HIGH FREQUENCY MANUAL

EBERHART

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A WORKING MANUAL OF HIGH FREQUENCY CURRENTS

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Author of "Practical X-ray Therapy;" Brief Guide to Vibratory Technique," etc.

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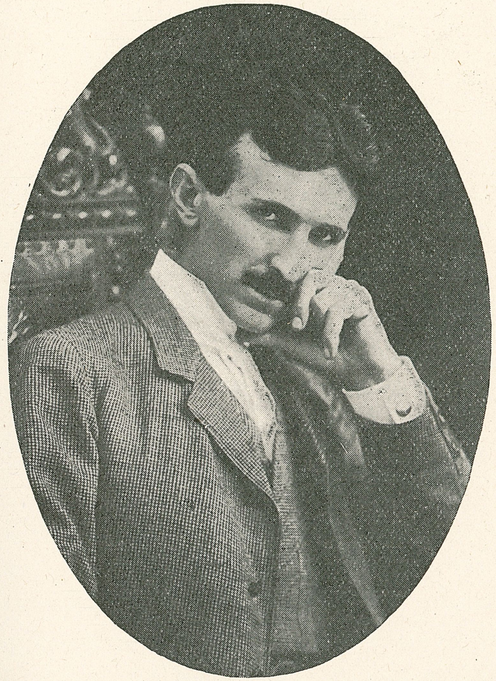

Nikola Tesla, Inventor of the Tesla Coil—Courtesy "Electrical Review and Western Electrician."

INTRODUCTION.

The literature on High Frequency Currents is not extensive and much of it is too technical for the average physician, who is more interested in the application of these currents than he is in the precise manner in which they are generated.

For this reason I have given comparatively little space to the consideration of the various forms of apparatus, other than to outline the types upon one or another of which all of the machines are based.

Further information along this line is properly within the sphere of the various manufacturers.

My intention has been to make this a practical hand-book for the busy physician who wishes to use high frequency currents and to learn how to do so with as little "red tape" as possible.

I have expressed my individual opinion on many points, and sometimes this may be found at variance with that of other authors, but it is based upon fifteen years' practical experience involving the daily use of High Frequency Currents and upon thirteen years' experience in teaching the subject.

My indebtedness for data furnished is acknowledged to Drs. W. B. Snow, W. H. King, H. E. Waite, F. de Krafft R. A. Black, E. C. Titus, H. F. Pitcher, S. Stevens, R. E. Farmer, and Messrs. F. H. Swett, J. B. Wantz, Wm. Meyer, Samuel T. Hutton, Edwin L. Edwards, H. L. Kahl, F. A. Wiggin, R. and F. H. Wappler, T. B. McClintock, C. E. Anderson, M. Sanchez, J. E. Clapp, H. W. Young and Wm. Stahl.

Also to Popular Electricity for the use of a number of illustrations.

THE AUTHOR.

25 E. Washington St., Chicago.

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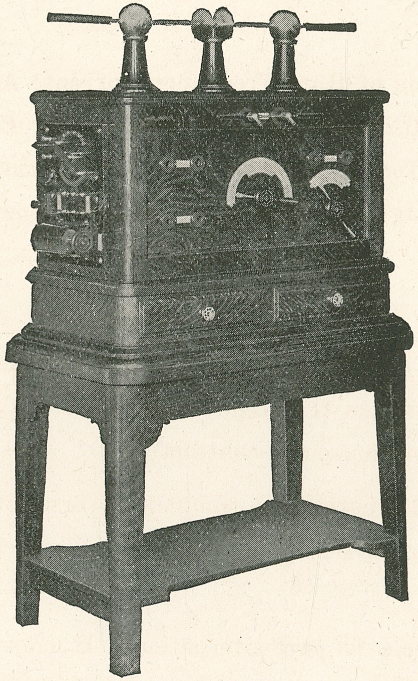


Fig. 1—Large Tesla Coil.

CHAPTER ONE.

Definition of High Frequency Current; Alternation; Cycle; Oscillation; Period; Frequency; Explanation of Terms; Pulsatory Currents; Periodicity; Lighting Vacuum Tube Not Proof of High Frequency Current.

What is a High Frequency Current? A high frequency current is an alternating (oscillating) current in which the frequency is beyond the point of producing muscular contractions.

An Alternation is a complete reversal of the direction of a current as any one of the waves shown in Fig. 3.

A Cycle is two alternations It constitutes the round or circle of the current, embracing one positive and one negative wave or alternation.

Oscillation. An oscillation is a series of diminishing waves which flow alternately in opposite direc-

tions, but not necessarily in the same time. Oscillatory currents periodically reproduce similar series of waves as shown in Fig. 3. Their frequency is very high and is the reciprocal of period. It is computed on the number of double alternations, thus corresponding to the method employed with low frequency currents.

Period is the time required for one cycle.

Frequency is the number of complete cycles occurring in one second of time. It is the reciprocal of period.

Explanation. In order to understand the foregoing definitions it will be necessary to recall some fundamental facts.

The **direct current** is one which always acts in one direction, that is from positive to negative, and is graphically represented by a straight line.

The **alternating current** in contrast to this, is one in which the current is constantly changing its direction or polarity, and we represent it by a waved line (Fig. 3), the waves above the line being pos-

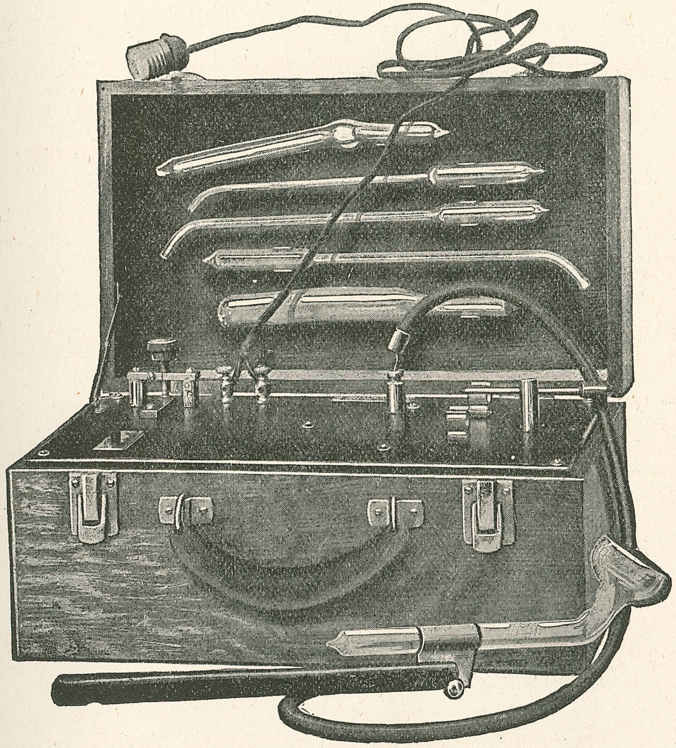


Fig. 2—Portable High Frequency Coil.

itive waves or alternations and those below the line negative waves.

Let us call the line zero in volts and the crest of the wave 110 volts. The current starts at zero, reaches the maximum positive voltage and then reverses and goes back to zero and repeats on the negative side. This complete reversal of the current is called an alternation and two of them make a cycle. If we only represented two alternations as in Fig. 4 and then made the second one return to the starting point as shown by the dotted line we would have in this case a circle, and the word circle will keep the meaning of cycle fixed in the mind. Alternations do not necessarily assume the shape of a semi-circle but may represent any form of wave, still two of them represent the completion of the circuit or cycle. In high frequency currents these cycles become a succession of oscillations or undulations as represented graphically in Fig. 3.

Frequency is a term properly belonging only to the alternating current. We have uni-directional currents such as those derived from induction coils,

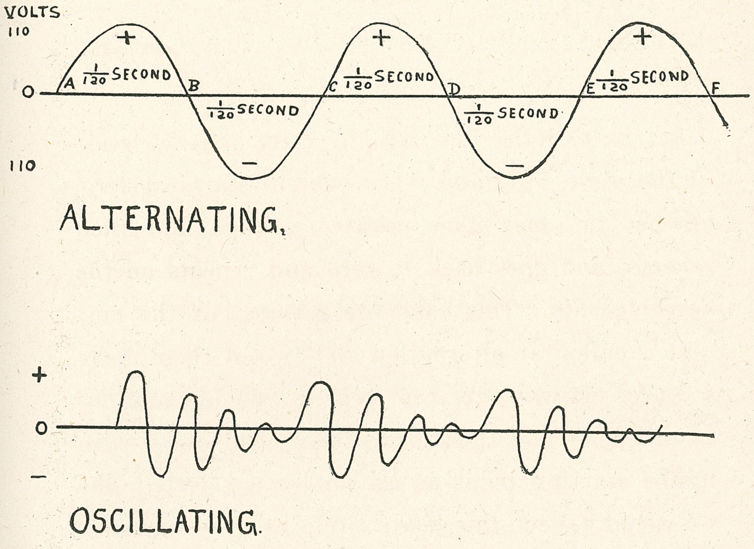


FIG. 3.

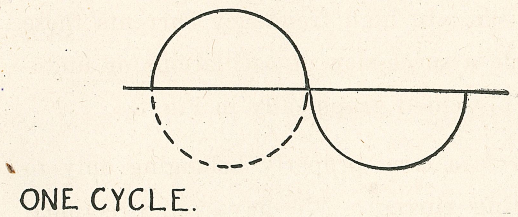


FIG. 4.

Fig. 3—Alternating and Oscillating Currents.
Fig. 4—Analogy Between Cycle and Circle,

in which the current is broken up into a rapid series of waves, with those which would be below the line damped out, leaving a succession of pulsations This current lights up vacuum tubes and performs much of the same work as the high frequency, but is not a true high frequency current.

These are called **pulsatory currents** and in place of the word frequency we indicate their rapidity by the term **periodicity.**

To return to our explanation of the alternating current let us suppose that it takes one-one hundred and twentieth of a second for any one of the alternations in Fig. 3. Then two alternations or one cycle would take two times one-one hundred and twentieth, which equals one-sixtieth of a second, and this is the period of the current illustrated. If it takes one-sixtieth of a second for one cycle, there will be sixty times as many in one second and this is the frequency.

It will be seen that if we have the period of the current, all that is necessary is to invert the fraction and we have the frequency or number of cycles.

In the illustration we have arbitrarily represented

an alternating current of 110 volts, sixty cycles, which is the ordinary commercial alternating current employed in electric lighting. It is a **low frequency current.** Other low frequency currents have 25 cycles, 125 cycles, 133 cycles, etc.

Low, Medium and High Frequency Currents. If we apply a low frequency current to a muscle we find that the muscle contracts, and this is powerful and may be strong enough to be painful. As we increase the frequency of the current the painfulness decreases, but more than a single muscle tends to contract. These are currents of **medium frequency** of which the **sinusoidal current** is a type.

At a frequency of about 10,000 cycles these tetanic contractions disappear and above that frequency there is neither pain nor gross muscular contraction.

The absence of pain is supposed to be due to the inability of the sensory nerves to comprehend such rapid alternations just as we have vibrations that cannot be recognized by the auditory nerve as sound or by the eye as light.

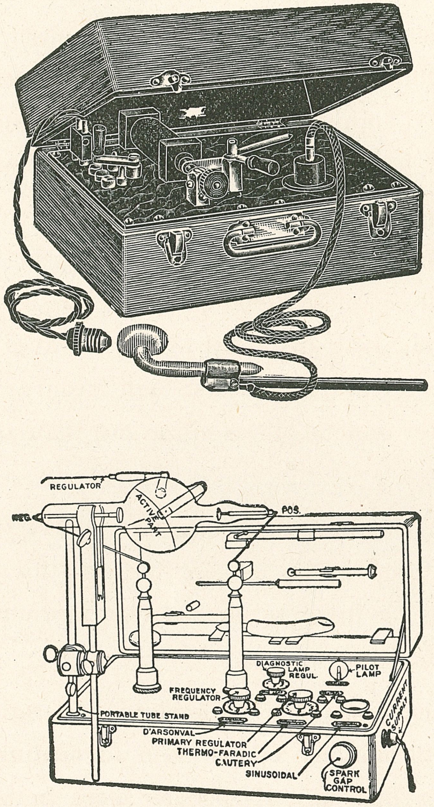


Fig. 5—Portable High Frequency Coils.

In these higher frequencies the contractile effect is expended upon the individual cells making up the tissues instead of on individual muscles. This I call **cellular massage** and it is one important reason why high frequency currents produce such a marked benefit on nutrition and metabolism.

As the current increases in frequency and voltage, other peculiarities appear and it no longer requires a complete metallic circuit but is capable of traversing long distances as ether waves as in the wireless telegraph. In fact high frequency currents are better understood as vibrations than as ordinary currents.

From the fact that muscular contractions cease with 10,000 cycles or oscillations, this has been taken as the dividing line between medium and high frequency currents.

As the frequency with some apparatus is estimated in millions, I have been advocating a higher dividing line, say 100,000 as more in proportion, but this would cause considerable confusion at present and so the original nomenclature is adhered to.

Lighting of Vacuum Tube Not Proof of High Frequency Current. As intimated above, exciting a vacuum tube as from the static machine or from one terminal of an induction coil is not proof of the presence of a high frequency current. To produce the high frequency current there must be attached to either of the above one of the several forms of high frequency apparatus described in Chapter III.

CHAPTER TWO.

The Development of the High Frequency Current; Leyden Jars; Plate Condensers; Electrical Oscillation.

The Development of High Frequency Therapy.

The therapeutic value of the high frequency current depends upon a number of physical phenomena, some of which were known many years before the high frequency was thought of.

In looking backward over electrical history, there are three points that bear particularly upon the development of high frequency therapy.

First: The invention of the Leyden jar, or an electrical condenser; secondly, the discovery of what is known as electrical oscillation; and finally, its application to the human body.

The Leyden Jar or Condenser. The Leyden jar was discovered in 1775 by Musschenbroek, and takes its name from the City of Leyden. It consists of a glass jar covered on both the outside and the inside with tin foil. (Fig. 7). These coverings only extend part way to the top of the jar. A chain from the cover of the jar connects with the inner layer, terminating above in a small rod with a ball tip. This is for the purpose of charging the jar by contact with the charging source or discharging it if this knob is brought nearly or quite in contact with a metallic conductor touching the outer layer.

The peculiarity of the Leyden jar consists in the fact that when a charge of electricity is placed on one of its layers, another charge of opposite polarity immediately appears on the other layer of the jar.

For instance, if the inner layer receives a positive charge, a negative one will be found on the outer lead foil and vice versa.

These charges will be held for some time unless something occurs to connect the two layers and al-

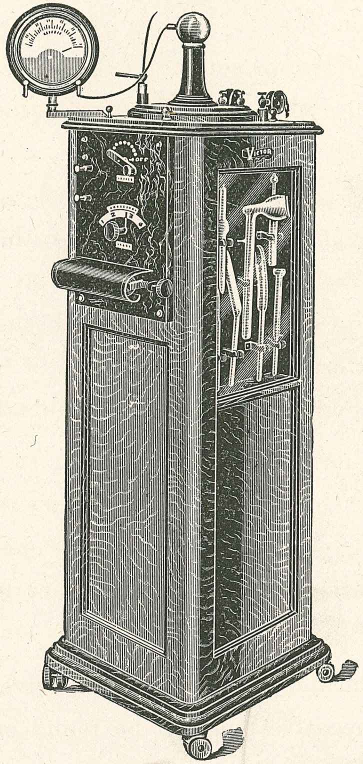


Fig. 6—High Frequency Coil, Giving All Modalities.

low the opposite kinds of electricity to neutralize one another.

In the Leyden jar then, we have two charges of electricity separated from one another by the glass, which, although it keeps the charges from getting to one another, does not prevent their exercising an attraction upon each other; or, to speak more precisely, the one charge induces an opposite charge on the other layer.

A substance which separates two charges of electricity in a condenser while still permitting them to have an influence on one another, is called a **di-electric.** Other di-electrics than glass are mica, vulcanite, etc. The contraction of the charge on the layer of the jar, causes a crowding together or condensing of the electrical ions, and thereby gives rise to the name **condenser** for the Leyden jar or the other form known as the plate condenser.

In the plate condenser we have two layers of tin foil separated by a plate of glass, thus keeping up the same relative arrangement that exists in the Leyden jar. To make the analogy more complete,

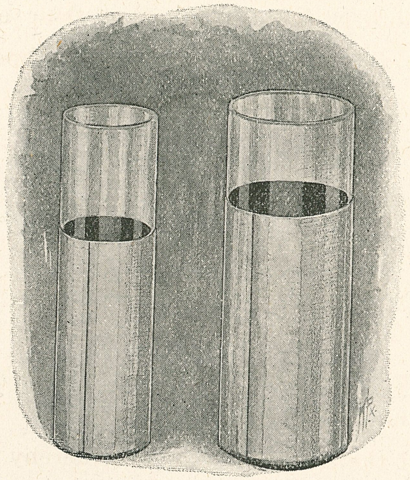
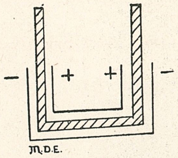


Fig. 7—Leyden Jars, Cylindrical Type.

I have been accustomed in my classes to make use of the illustration in Fig. 8, showing a section of a Leyden jar; and then supposing that this were made of flexible material, let us imagine that we took hold of the ends of the section and straightened it out when it would appear as in Fig. 9, which represents a cross section of a plate condenser.



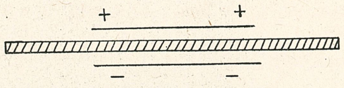


Fig. 8—Section of Jar. Fig. 9—Section of Plate Condenser.

Electrical Oscillation. When a Leyden jar or other condenser is discharged through an air space, there is apparently a single spark passing across the gap. From the time of the discovery of the jar in 1775 until 1842, this was supposed to be the case. At this time Professor Henry announced in reality there was a series of sparks passing back and forth between the terminals of the spark gap. This phenomenon has received the name electrical oscilla-

tion. It has been compared to the action of two columns of water of different heights connected at the bottom by a pipe with a valve in it. When the valve is opened, since water seeks its own level, the higher column descends, and the lower column rises. As a result of the action of gravity on the greater weight of the higher column, instead of the column descending until level with the other column and then stopping, this force carries it below until it becomes the lower column and the other column the higher one, and thus the two columns balance back and forth until finally they come to rest at a level.

Another illustration may be made use of in the pendulum, which when raised to one side and released, swings over the opposite side nearly as far, and so back and forth through shorter and shorter arcs until it finally stops in the center.

Electricity following the same principle as it passes from a higher to a lower potential, produces a similar oscillation.

Lodge gave an especially suitable illustration by likening the action to the vibration of a straight steel spring fastened at one end.

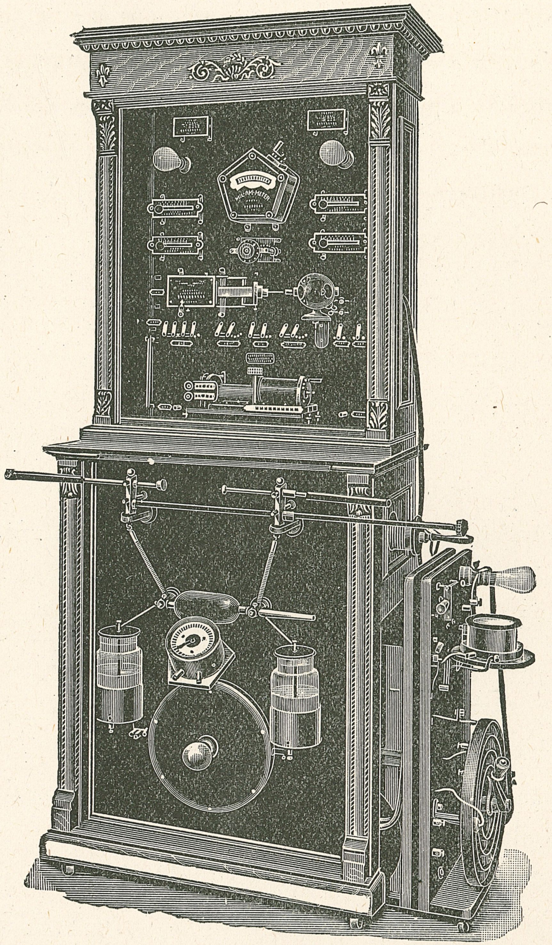


Fig. 10—Large High Frequency Outfit.

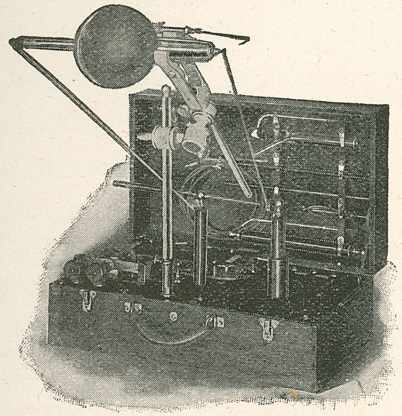
Electrical oscillation is the keynote in the therapeutic application of high frequency currents, although it was nearly forty years after its discovery before anyone thought of applying the principle in the treatment of the human body.

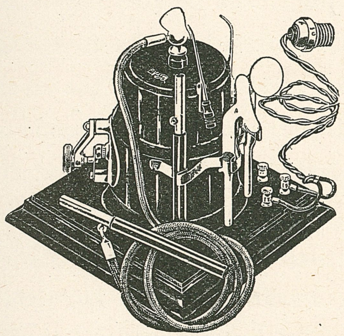
CHAPTER THREE.

Types of Apparatus; D'Arsonval Type; Tesla Transformers; Impedance; Direct D'Arsonval Currents; Auto-Conduction; Auto-Condensation; Resonator of Oudin; Tuning Coils; Measuring the Current.

Types of Apparatus. There is no intention on the part of the author to encumber this volume with lengthy descriptions of apparatus. For such information, the reader is referred to the manufacturers of electrical outfits.

All high frequency instruments, however, are constructed along two principal types—that of D'Arsonval and that of Tesla, and these should be understood by the high frequency operator since all





Figs. 11 and 12—Portable Coils.

machines represent one or the other or a combination of these types.

In connection or combination with them, a third instrument, the resonator of Oudin, is in such common use that it also calls for special description. In speaking of high frequency currents, to be specific, we should always state the form of current used, as D'Arsonval high frequency, or Tesla high frequency, etc.

The D'Arsonval type of apparatus as it is manufactured today consists of a combination of the D'Arsonval solenoid and an improved type of the Oudin resonator. The Oudin current derived from this type of apparatus serves to energize vacuum electrodes, the spray electrode, the so-called "static spark" electrode, the portable ozone inhaler, and also is the current which is utilized for obtaining the "cold" fulguration spark. The D'Arsonval solenoid is utilized for auto-condensation, auto-conduction and diathermy. The D'Arsonval solenoid in this instance delivers a comparatively low potential and high milliamperage current.

The Tesla type of apparatus is designed along the

same general lines as is the D'Arsonval and has the same wide range of usefulness but the general characteristics of the current are different in that the Tesla type of apparatus delivers a high potential, low milliamperage current.

If every physician employing high frequency apparatus was aware of this difference it is the author's opinion that many cases of misunderstanding and dissatisfaction would be cleared away.

In other words the **milliamperage reading of the meter is not an indicator of the capacity or power of the apparatus.** This means that 500 milliamperes of Tesla high frequency current is just as capable of producing deep constitutional effects as 1,500 milliamperes on a D'Arsonval high frequency apparatus.

The relative merit of the "Tesla" versus the "D'Arsonval" apparatus more particularly as regards auto-condensation and diathermy has been the subject of numerous discussions among electro-therapeutists. The thickness of the di-electric (auto-condensation cushion) has also entered into this discussion. It has been proved that either type is cap-

able of producing results and in consequence thereof the author does not feel capable of choosing himself as the sole arbitrator in deciding which is better. He, however, for the past three years has been employing the Tesla type of apparatus in his individual practice and has been deriving eminent satisfaction from its use. He employs a cushion of approximately three inches in thickness—this size being endorsed by the standardization committee of the American Electro-Therapeutic Association.

As will be stated in Chapter VI, the author originated the thin cushion as well as the portable thick pad, and the method of making these different forms is given. He bows to the ruling of the committee referred to above and now employs only the thicker cushion.

The D'Arsonval Current is one of high frequency, not very high voltage, and high amperage.

It is administered as a bi-polar method, thereby producing constitutional effects. D'Arsonval started with an induction coil attached to the direct current. The terminals of the secondary coil were attached to the inner layers of two Leyden jars, there-

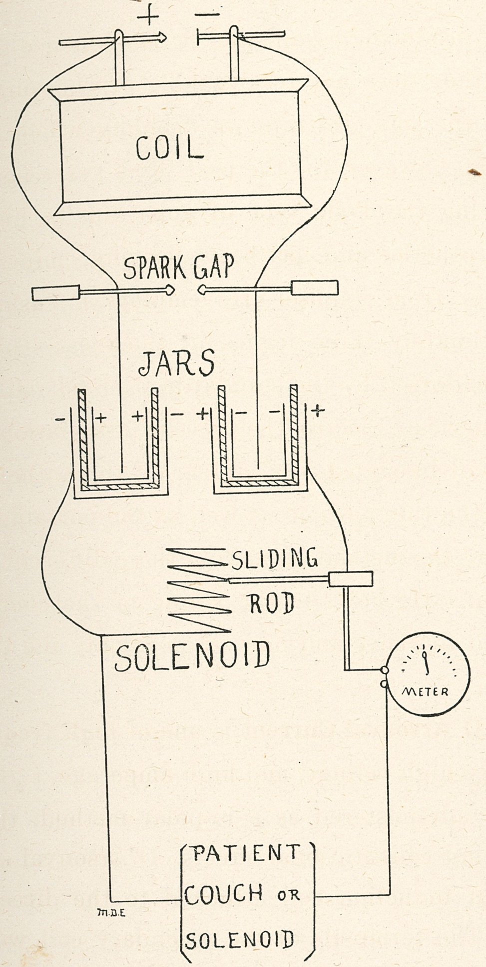


Fig. 13—Diagram of D'Arsonval Type.

by charging one of them positively and the other negatively. In the circuit between these two layers was placed an adjustable spark gap. Between the outer layers of the jars was placed a solenoid or coil consisting of fifteen to twenty turns of coarse copper wire. **This combination of condensers connecting on one side through a spark gap, and on the other through a coil of wire, is an absolute necessity in order to obtain the D'Arsonval current,** and it therefore constitutes this type. See Fig. 13.

When the positive layer of the first receives a sufficiently high charge, it jumps across the spark gap to neutralize the negative charge in the second jar. Immediately the positive charge on the outer layer of the second jar is released and passes through the coil of wire to neutralize the negative charge on the outer layer of the first jar, and as it passes through this coil or solenoid, it produces a high frequency current, keeping in mind the fact that the oscillation back and forth through the condensers exists as described in Chapter II. The patient is connected on that side of the condensers that discharges through the coil and is really on a shunt or

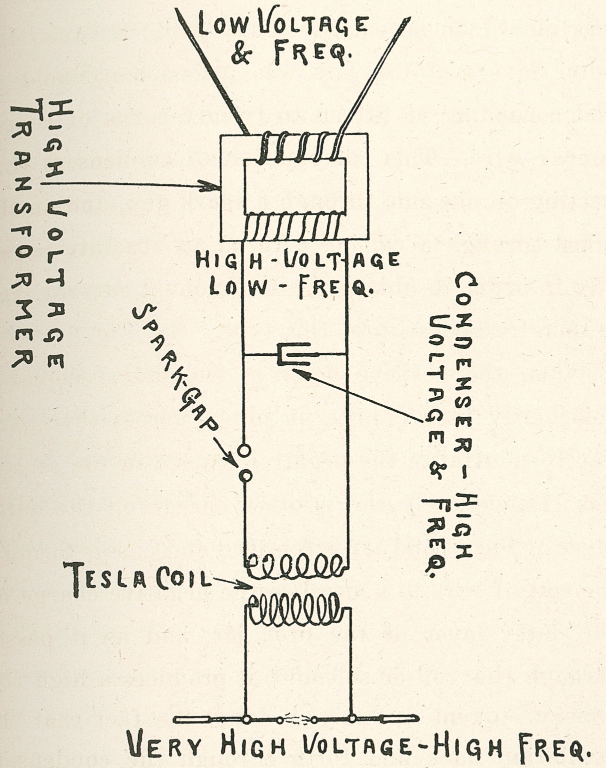


Fig. 14—Diagram of Tesla Type.

switch from that part of the circuit, and the reason the patient receives any current at all, is because the solenoid possesses the property known as self-inductance, which impedes the passage of the current, allowing part of it to go through the lesser resistance in the patient's circuit. The process of interfering with the current as a result of the self-inductance is called **impedance.**

The Tesla Transformer and Coil. Tesla started with the alternating current, and by referring to our definition of high frequency currents (Chapter I.), it is seen that all that was required was the increasing of the frequency to a point which we properly call high. To do this, he used as a primary, a coarse coil of wire consisting of a few turns only, while the secondary coil consisted of an extraordinary number of turns of very fine wire—the result being that the current induced therein was of very high tension and very high frequency. The Tesla transformer or coil, is especially adapted to the alternating current. It is employed in all of the portable high frequency apparatus on the market. The Tesla primary resembles the D'Arsonval current ex-

cept the amperage is less. Fig. 14 shows one method of evolving the various currents.

Administration of the D'Arsonval Current. There are three principal ways in which this current is applied to the body; first, the direct bi-polar method, which has also been subdivided into two or three forms; second, auto-conduction, and third, auto-condensation. In the first method, the patient is directly connected to the terminals of the apparatus. Whether the patient holds the two electrodes, or whether he is attached to one pole, while the other pole is connected with an electrode in the hands of the operator, the method is still called direct application. It should be borne in mind that the direct D'Arsonval current is also known under several other terms, such as diathermy, electro-coagulation and thermo-penetration. See Chapter XI. Referring back for a moment to the component elements of the D'Arsonval apparatus, it is seen that solenoids and condensers are fundamental parts. In the elementary D'Arsonval type we have one set of condensers and one solenoid. It would appear, therefore, that the inventor said to himself: "If

one solenoid gives a current of high frequency, let us add another solenoid and see what that will do.'' Thus the second type, auto-conduction, is constructed, and a large solenoid is connected in the shunt which forms the patient's circuit, and it is made so large that the patient may be placed within this coil or cage when it is found that as the high frequency currents traverse the coil, other high frequency currents are induced in the body of the patient. This is auto-conduction.

Auto-condensation. Again reverting to our elementary type instead of using the second solenoid, the next arrangement was the use of an extra condenser, and the current passes from one terminal into one plate of the condenser, while the other plate was formed by the body of the patient, hence the term auto-condensation.

Oudin's Resonator. Oudin discovered that with a coil of wire properly tuned or adjusted to the coarse coil or solenoid of D'Arsonval, the electrical currents of the latter produced currents of such strength that they might be taken from the terminal of the larger solenoid and applied to the body. They are

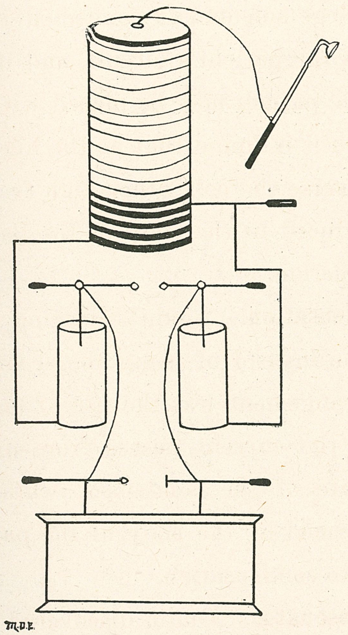


Fig. 15—Diagram of Oudin Resonator.

of high frequency, high voltage and low amperage, resembling the Tesla secondary. As ordinarily constructed, the D'Arsonval apparatus and the resonator are combined in one instrument; the resonator proper consisting of a large coil of fine wire placed above the coarse solenoid of the D'Arsonval machine. See Fig. 15.

Tuning Coils. The best results in resonance are obtained when the coils are properly adjusted and attuned to one another. To facilitate this, the wire that passes from one side of the solenoid is attached to a sliding metal finger, which may be moved up or down on the solenoid and thereby increase or decrease the number of turns of wire employed. This permits proper adjustment of the coils at the same time it is found that the greater the number of turns included, the sharper the resulting spark, and vice versa.

Measuring High Frequency Currents. High frequency currents cannot be measured with an ordinary meter. For D'Arsonval currents the method customarily employed is the use of a hot wire meter. This is really a thermostat instead of an elec-

trical device. It is based upon the fact that the passage of the high frequency current gives rise to heat and this heat causes expansion in a platinum wire and thereby deflects the needle in proportion. Hot wire meters are faulty, but give a relative idea of dosage when employed on the same apparatus.

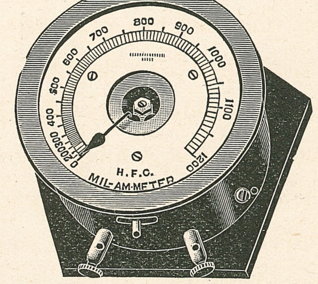


Fig. 16—Hot Wire Meter.

One is shown in Fig. 16. Other methods of measuring these currents are by Gaiffe and Meylon's induction amperemeter, which "measures the repulsive force between the original current and the current which it induces in a coil attached to the indicator."

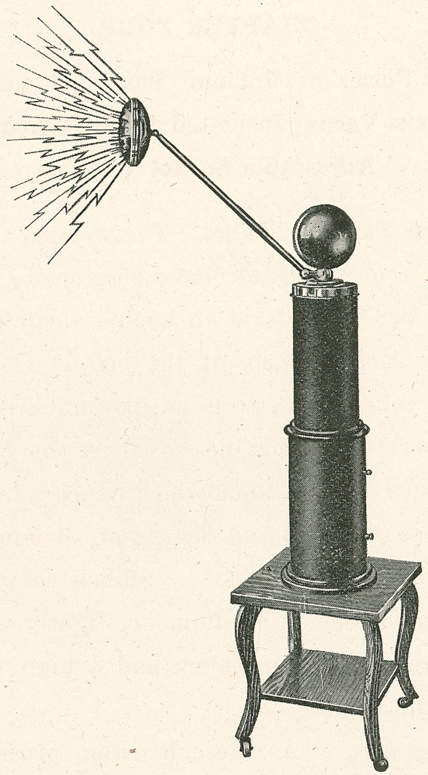


Fig. 17—Resonator for Static Machine.

CHAPTER FOUR.

Various Forms of Vacuum Tubes; Effects of Different Vacua; Insulated Tubes; Fixed and Adjustable Socket Handles.

Various Forms of Tubes. The vacuum tubes used in high frequency work have been made in almost every conceivable form to enable them to be applied to various parts of the body. The vacuum of these tubes varies from one-five hundredth of an atmosphere up to that possessed by the X-ray, one one-millionth. The color which appears in the tube varies according to the degree of vacuum; thus a low vacuum will produce a reddish color or glow in the tube; one of medium or slightly above medium vacuum, a blue color; and a high vacuum a white appearance.

Strong says, "As the exhaustion proceeds from one-five hundredth to one-ten thousandth of an atmosphere, the disks become thicker and the striations fewer, and the color changes from a rose-pink

to violet, blue (one one-thousandth), blue-white, and finally to a dense yellow-white. A low X-ray vacuum would be about one one-hundred thousandth of an atmosphere.''

Besides the degree of vacuum, the light is also supposed to be influenced by the kind of gas remaining in the tube, and some authorities claim that there is a direct analogy between the rapidity of the oscillations at the spark gap and the color of light in the tube. As the lowest number of vibrations producing the color ''red'' is 450 billions per second and the highest violet 750 billions, this analogy seems improbable.

The low vacuum tubes give off more heat, while the high ones give some chemical (ultra-violet) rays and if very high, X-rays.

The red or red-pink vacuum besides giving off more heat, is sedative and useful in painful conditions and in acute diseases and inflamation.

The medium, blue, or blue-white vacuum gives off some chemical rays, and is more appropriate in chronic conditions. It is often employed where the white vacuum would really be indicated as this

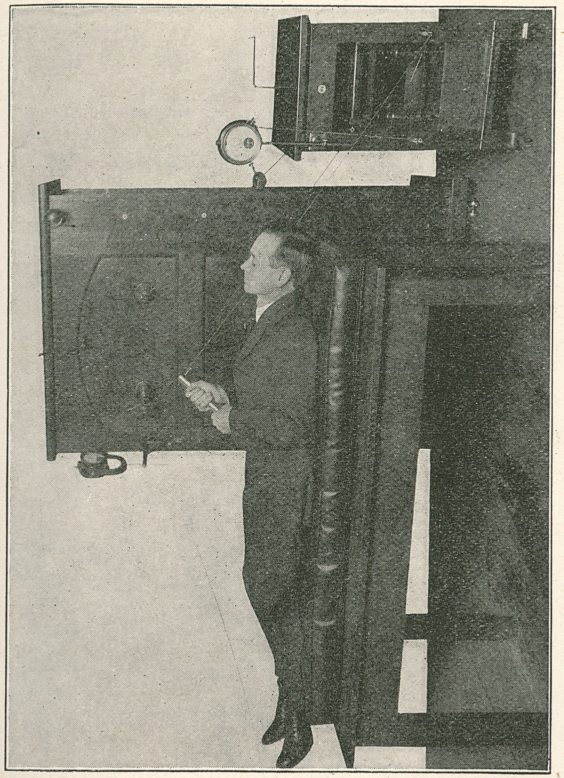
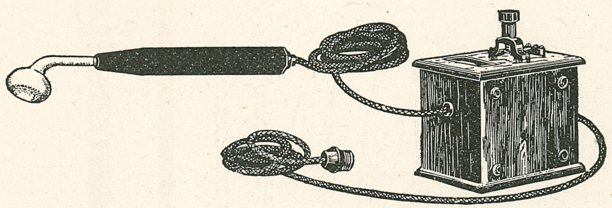


Fig. 18—Interrupterless Transformer, with Resonator Employed in Giving Auto-condensation.



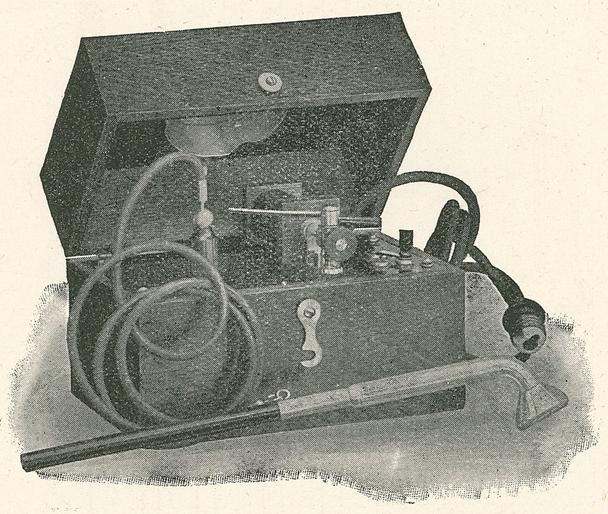


Fig. 19—Portable Outfits.

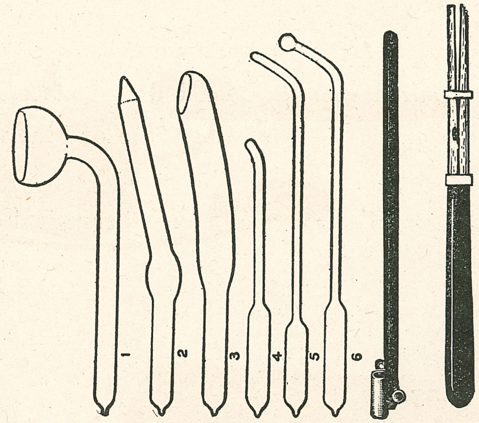
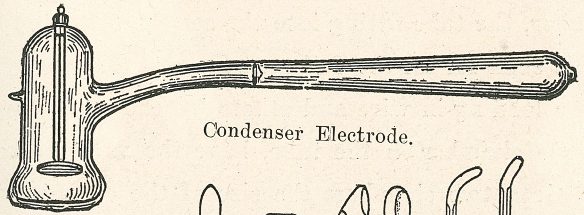


Fig. 20—Tubes and Handles.



Condenser Electrode.

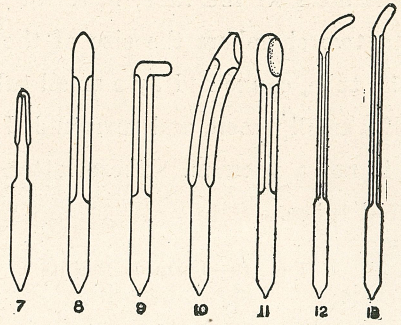


Fig. 21—Insulated Tubes.

contains not only blue and violet, but also some ultra-violet rays. All chronic ailments, where the vitality is impaired, skin diseases, indolent ulcers, etc., call for the employment of the white or blue-white tube.

Much of the foregoing is more theoretical than it is practical and I have finally come to the conclusion that a medium vacuum electrode (purple tinge) answers all practical purposes, and this is what I am now using.

Vacuum tubes are ordinarily made in a single chamber, the tube fitting into the socket of a handle that is used for all the different forms. Some tubes have a leading-in wire and others instead of having a single chamber in the tube, have the vacuum divided into two chambers the size of the circumference of the tube, connected by a small tube, possibly the size of a small pencil, and surrounded by a chamber that is not a vacuum. These latter are known as insulated tubes.

The tubes used most frequently are shown in Fig. 20. No. 1 is the **body tube** which is used also in treating face and scalp. No. 2 is the **rectal tube**;

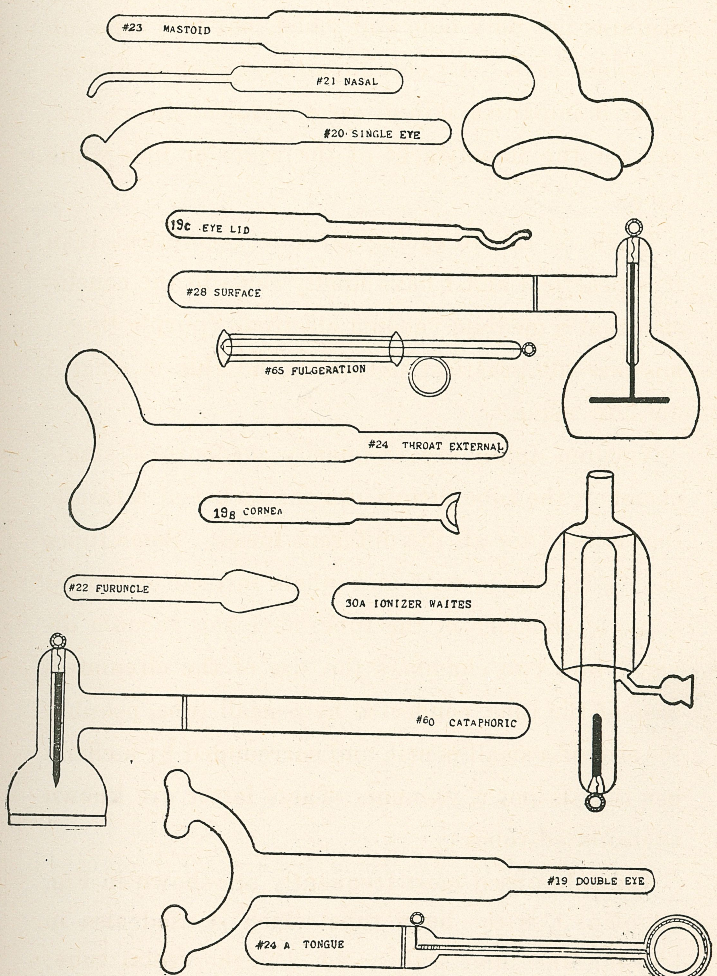


Fig. 22—Various Types of Tubes.

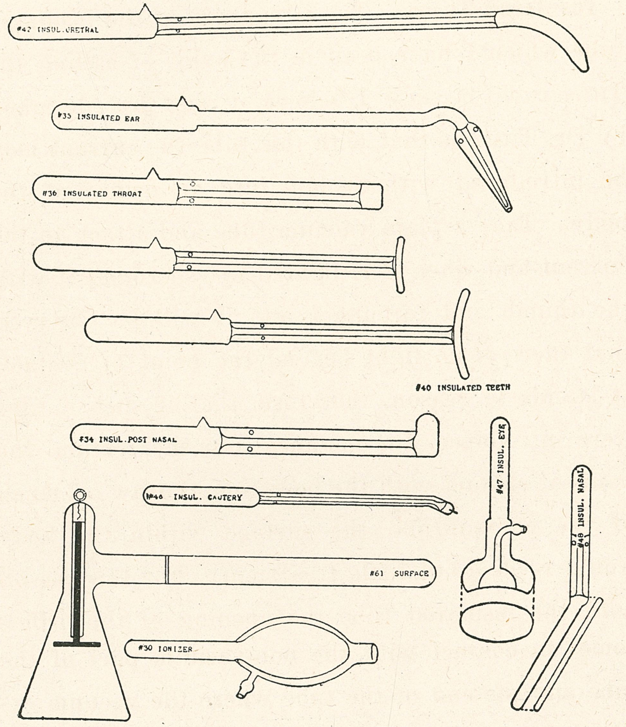


Fig. 23—Vacuum Tubes.

3, **vaginal**; 4, **nasal**; 5, **urethral or aural**; 6, **throat.** In place of No. 1, No. 11, Fig. 21 will be found equally useful and in some instances superior on account of the ridges around the depression, enabling it to be used where it would be difficult to place the body tube.

Insulated Tubes. The advantage of the insulated tube which I have been in the habit of calling the Titus tube, because I believe it was first designed by Dr. Titus, is that with this tube the current may be introduced without loss into an orifice of the body. Take a plain vacuum tube and attach to the current and when it is lighted up, surround it with the thumb and forefinger and it will be observed that there is no light beyond the point of contact. It stands to reason, therefore, that if such a tube were introduced, for instance into the rectum, the point of contact with the body would draw off much of the current and the surface within the body would receive but little treatment. For this reason with the insulated tube the opening of the orifice comes in contact with the non-vacuum part of the tube and the end of the tube where the vacuum exists thus conveys all of the current in at the desired point.

I have been taken to task for my statement above, on the ground that contact with the encircling finger possesses no capacity. It simulates, however, the conditions of certain orificial treatments and after

trying the experiment referred to, I am sure the physician will resort to the use of insulated tubes for rectal and other orificial work.

The principal forms of insulated tubes in use are shown in Fig. 21. No. 7 is for the ear; 8, rectal, or prostatic; 9, post-nasal; 10, for vagina or uterus; 11, prostatic or for general surface use; 12, urethral or aural; 13, nasal.

The Adjustable Socket Handle. The ordinary holder for high frequency tubes consists of a straight handle with a metal socket into which the tube is received as shown in Fig. 20. This is suitable for holding electrodes that are applied to the surfaces of the body, but for most conditions I prefer a handle with a movable or adjustable socket. Fig. 20 This socket may be placed at any angle to the handle that may be desired and with a thumb screw made secure at this point necessary. The advantage of this will be discussed in detail in Chapter VII, when considering the special technique for various portions of the body.

The latest type of my adjustable handle is shown in Fig. 24. It is of spring steel and accommodates tubes of varying diameters.

Author's Spatulate Tubes. I have recently de-

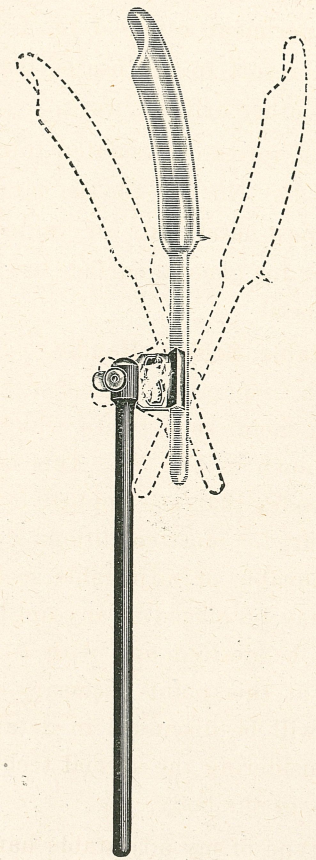


Fig. 24—Author's Latest Adjustable Handle.

signed the tubes shown in Fig. 27. They end in a flattened spatulate extremity. In the body tube the

end is at an angle with the main tube, thus making it much handier to use than the regulation type of body electrode.

The vaginal, prostatic and rectal tubes are similar in shape, but are straight. They vary only in size and are made both plain and insulated.

The physician who has been using vaginal and prostatic tubes will readily perceive the advantages of the larger flat surface. Either of these tubes will be found quite satisfactory for surface applications.

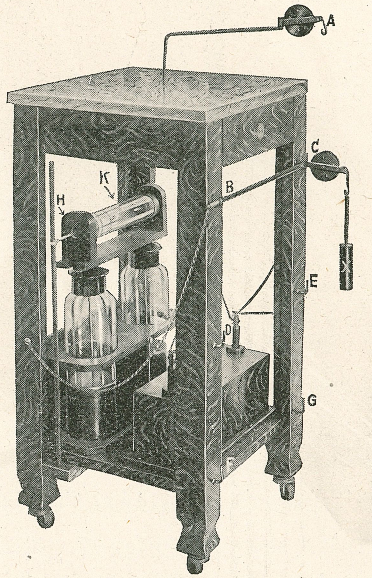


Fig. 25—Resonator for X-Ray Coil.

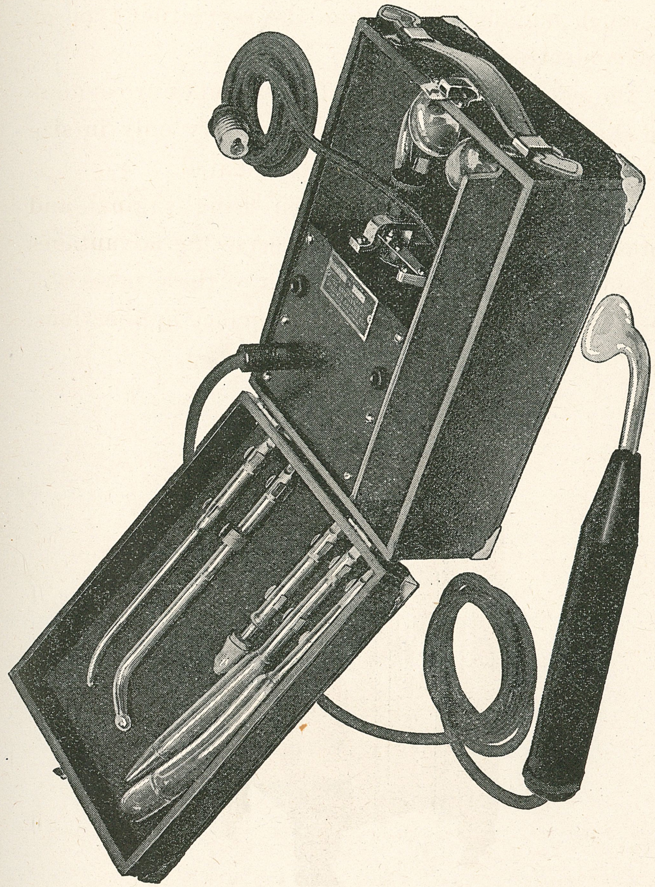


Fig. 26—A Compact Portable Outfit.

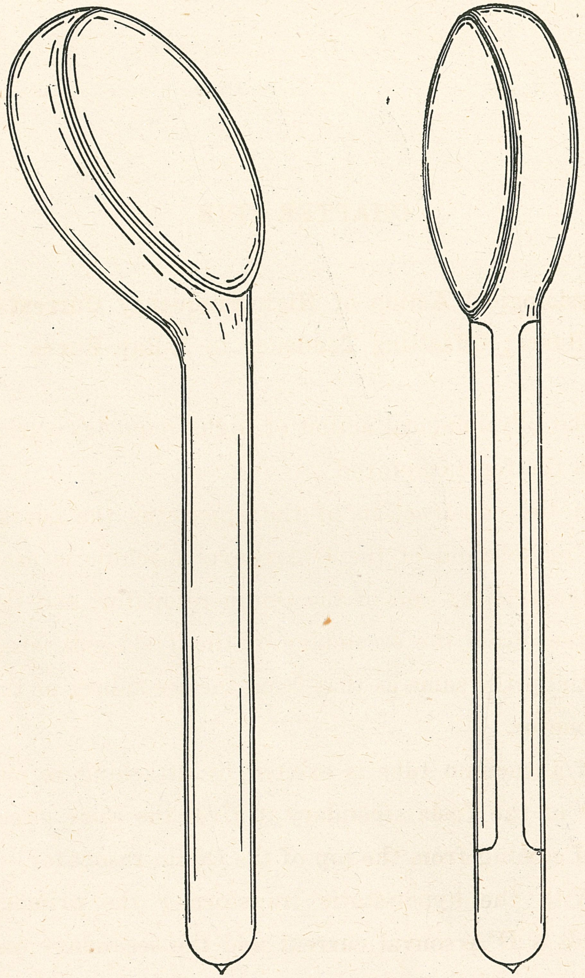


Fig. 27—Author's New Spatulate Tubes.

CHAPTER FIVE

Physiological Action of High Frequency Currents; Burns; Offsetting Tendency to X-Ray Burns.

The physiological action of high frequency varies with the form employed.

In the construction of the apparatus the coarse coil or solenoid of the D'Arsonval machine is used as the primary coil of the Oudin resonator, and the current from the secondary of the Tesla coil is essentially the same as that from the secondary of the resonator.

If a vacuum tube is excited by attaching to one pole of the Tesla secondary it gives the same effect as if coming from the top of the Oudin resonator.

With the hyper-static transformer the primary yields a D'Arsonval current and the secondary one similar to that of the resonator or Tesla secondary.

When vacuum tubes are applied locally there is soon produced redness and hyperemia, with all of the resultant benefits on nutrition.

In short, the fundamental value of high frequency currents is their beneficial effect on all nutritive processes. Incidental to this we have increased oxygenation of blood and tissues, increased leucocytosis (and phagocytosis); and increased elimination.

There is no painful sensation produced by the vacuum tube when held firmly in the hand, thus establishing complete electrical contact. Ordinarily there is a sensation of heat and in some instances perceptible vibration. Removing the tube produces a spark which increases in sharpness as the tube is drawn away, up to the full length spark it is capable of emitting. The longest spark which may be drawn from the tube has been my method of roughly calculating the strength of the current and the regulation of the dosage. See Chapter VI.

General Action of Vacuum Electrode. In a general way the action of the current when applied by means of the glass vacuum electrode is as follows: A mild current with tube in contact is sedative. As

the current is increased, or the electrode removed from the surface, allowing a spark to pass, it becomes first mildly stimulating, then strongly stimulating and finally caustic or destructive. The whole gradation of effect from sedation to cauterization being essentially a question of current intensity and length or sharpness of spark.

With this is the effect of hyperemia and the germicidal action of the spark and the ozone which it liberates.

Summary of Vacuum Tube Effects, from Oudin resonator or Tesla secondary:

1. Increase blood-supply to a given area. (Hyperemia.
2. Increase oxidation and local nutrition.
3. Increase oxygenation of blood.
4. Increase intake of oxygen.
5. Increase output of carbon dioxide.
6. Increase secretions.
7. Increase elimination of waste products.
8. Liberate ozone, with the resultant benefit of more or less of this ozone being inhaled by the pa-

tient, and also probably carried directly into the tissues.

9. Increase bodily heat, without a corresponding rise in temperature.

10. Locally germicidal.

11. Mild and medium sparks stimulate or soothe according to length and character of application.

12. Strong sparks are caustic.

13. Sparks to spine increase arterial tension.

14. Promote absorption of plastic exudates or adhesions.

These effects of vacuum tube aplications while essentially local, are not absolutely so. The current traverses the body in all directions from the point of entry, but is, of course, most intense and pronounced at the latter point. Prolonged applications of vacuum tubes will give systemic effects, but these are obtained more easily by auto-condensation.

Constitutional Effects. These are derived through auto-condensation and auto-conduction. These currents increase bodily heat, almost always showing

a rise of from one-half to one and a half degrees in temperature during a ten-minute application.

Some attribute the effect of these currents to the heat they develop in the tissues. In my opinion their principal effects are due to "cellular massage." They have, therefore, a great effect upon metabolism.

The effect of auto-condensation in producing cellular massage is appreciated when we realize that the charge in the patient's body must return back into the circuit and then alternate with one of opposite polarity, thus, first a positive and then a negative charge is carried into the body and back again. This produces a to-and-fro wave that acts upon every cell in the organism. No sensation is usually perceptible if perfect electrical contact with the patient exists in the latter's circuit.

Synopsis of Constitutional Effects:

1. Increase general metabolism.
2. Increase glandular activity.
3. Increase temperature and bodily heat.
4. Increase oxidation and hemoglobin.

5. Insrease secretions.

6. Increase elimination.

7. Lower blood-pressure when hypertension exists.

8. Soothing to the nervous system.

High Frequency Burns. This is a subject which has not been touched upon in the literature on high frequency. There is a prevalent idea among many operators that these currents do not and cannot produce a burn. True, they do not cause a dermatitis, comparable to that produced by the X-ray, but they are still capable of causing annoying surface burns.

It will be noted by the physician who is accustomed to handling the excited tube with his hands that after a time the skin, especially about the finger tips, feels as if he had been handling a hot dish, that had seared the outer skin. Also in giving vaginal treatments, prolonged application may result in shreds of the mucous membrane adhering to the tube when it is withdrawn. **To avoid this, I make it a rule never to leave a vacuum tube in contact**

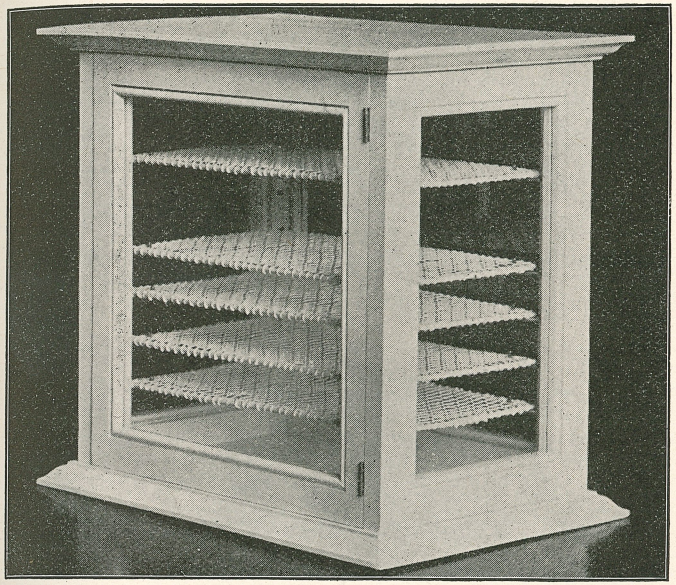


Fig. 28—Formalin Sterilizer.

with a mucous membrane for more than seven minutes at a time. Occasionally the urgency of a case is such that I am willing to give longer treatments and take the chance of a possible burn.

High frequency currents seem to have no cumulative effect in so far as burning is concerned, and treatment may be repeated frequently without any apparent danger; thus three seven-minute treatments may be given in one day with intervals of three to six hours between, without any serious consequence when one twenty-minute treatment may be disastrous.

High frequency burns appear immediately; there is no interval as with the X-ray. Another use of the high frequency in which burns may result is in the application of the spark to a mucous membrane, as for instance, to the lip, where care and judgment must be used.

I have seen a fairly sharp application to a "cold sore" result in the formation of a large vesicle which ruptured and poured forth an incredible amount of serum and was three weeks in healing.

As a sharp spark has a cauterizing effect and is used for that purpose, it is readily inferred that the reaction just referred to is of this nature, as even a comparatively mild spark will influence a mucous membrane.

Another condition in which these currents must be used with care is about the neck or scalp, where there is a fine, fuzzy growth of hair, as with some forms of apparatus having considerable amperage, enough current comes through to produce a spark capable of setting fire to any inflammable substance.

This property of the high frequency spark may be easily demonstrated by lighting a gas jet with it. I have been told of one or two instances where severe burns occurred from the spreading of the tiny flame to the hair on the head.

I wish to specially caution against the danger of using the high frequency spark on the scalp in connection with lotions containing a high per cent of alcohol or other readily inflammable material. Where such lotions are employed, the high frequency spark must be used first and the lotion applied thereafter, or a serious accident may happen.

The same point must be kept in mind when using the cataphoric electrode.

Offsetting Tendency to X-Ray Burns. While I am touching on the subject of burns I wish to call attention to a use which I have made of the high frequency current, regarding which I have seen no reference elsewhere. This is the use of this current to offset some of the effects of the X-ray, and by its use in conjunction with the latter, to enable a larger dose of the X-ray to be administered without a corresponding degree of danger. A stimulating application is used to the point of producing some reddening of the skin.

The ultimate action of the application of the X-ray is to cause a decreased amount of blood in the part treated through the action of the ray in increasing the cellular lining of the arterioles and thereby producing a diminution in their caliber. It is well known that in deep X-ray burns we have a condition of starvation and death of tissues, resulting from insufficient nourishment. Now, as far as the action of the high frequency current on the vessels is concerned it is diametrically opposite. It increases the blood-supply to the part treated, and to this extent it tends to offset the anemia produced by the X-ray. Otherwise the two methods usually act in harmony with one another in a large number of diseases, particularly those affecting the skin, and by combining the two, a greater amount of X-ray may be safely used, while its action is hastened by the complementary effect of the high frequency current.

This must not confound the reader with the action of strong sparks, which, as in fulguration, destroy arterioles, or produce an endarteritis similar to that caused by the X-ray.

CHAPTER SIX.

General Technique; Vacuum Tubes; Lubrication; Cautions; Asepsis; Method of Standardizing Dosage; Author's Unit for Measuring Auto-Condensation; Preparation of Patient; Technique for Skin Diseases or Surface Lesion; for Relief of Pain; Cauterization; Orificial Technique; Cataphoresis; Bi-Polar Tesla Technique; Selection of Most Suitable Form of Current; Fulguration; Constitutional Treatment; Auto-Conduction; Auto-Condensation; Portable Pads; Home-Made Couches and Pads; D'Arsonval "Surgings"; Water Spray; Local Auto-Condensation; Indirect Sparks; Taking the Blood Pressure; Miscellaneous Suggestions; Diathermy.

One author gives upwards of twenty different methods of using high frequency currents. This is apt to prove confusing to the ordinary user of these currents, and I have reduced the headings under which to discuss technique to those methods most commonly in vogue.

Classification of Technique:

1. Vacuum tube technique. (Tube excited by Oudin or Tesla currents)
2. Fulguration.
3. Constitutional (auto-condensation and auto-conduction.)
4. Diathermy. (Direct D'Arsonval; electro-coagulation; thermo-penetration.)

1. VACUUM TUBE TECHNIQUE.

This involves the use of the tubes by direct contact, by effleuve (fine spray) and by actual sparks, from the mildest form to the sharp caustic forms. It may be classified otherwise according to its use as in (a) skin diseases, ulcers, inflammatory processes, etc; (b) relief of pain, as in neuralgias, etc.; (c) orificial application.

Vacuum tubes are employed where an essentially local effect is desired.

Lubrication of Tubes. Any of the lubricating jellies, unguents or cerates may be employed on tubes used within the urethra, vagina or rectum.

Vaseline answers very well, for, although it is a non-conductor of ordinary electricity, the thin coating required on these tubes is absolutely no bar to high frequency currents.

Cautions. 1. As stated in Chapter V, high frequency currents are capable of producing annoying but not ordinarily serious surface burns. These effects are especially quick to appear when mucous surfaces are treated, as in rectal, vaginal, urethral or nasal applications, and also in treating diseased areas about the lips. On this account the application should be relatively short and mild if a spark is employed in treating within the various orifices. Make it a general rule never to allow a vacuum tube to remain in contact with a mucous membrane for more than seven minutes at one treatment.

2. When the current is one of relatively high amperage, the spark will set fire to any easily inflammable material. This may be illustrated by lighting the gas with the spark, as previously referred to. On this account care must be exercised in treating in certain areas.

3. When introducing glass sounds into the male urethra great care must be exercised not to use any undue force and thereby break off the glass tube within the canal. These tubes are made of strong glass, but may be broken by unusual pressure, or by a sudden jerk. If difficult of introduction it is better to pass steel sounds first to a size larger than the glass sound, as suggested in Chapter VII under Urethral Technique.

Care of Vacuum Tubes. Asepsis. Although the spark or effleuve from the vacuum tube is germicidal in character, still it is the duty of the physician to use the utmost care and cleanliness in employing it in order to guard against any possibility of spreading infection from one patient to another.

In other words he would better follow some defninite system of sterilizing and disinfecting the tubes, and the nearer this is to surgical asepsis the better.

Wiping off the tubes on a cloth or towel or simply rinsing in water is not enough.

Apply the test to yourself. How would you like to be treated with a tube that had been used in

contact with a specific disease and which had received no further cleaning than mere dipping in water and then being wiped off with a towel that had already done similar service an indefinite number of times?

Let your technique be so careful and conscientious that you need never blame yourself for spreading contagion or infection of any kind.

This is a subject that I have not seen mentioned in any treatises on high frequency currents.

Do not use the same tube for specific and non-specific orificial cases. This alone will do much toward lessening the danger of infection.

As these tubes bear heating, they may be sterilized by boiling, just as surgical instruments are sterilized.

This, however, is not necessary as immersion in strong antiseptic solutions will be sufficient.

A tube that is to be used in contact with a mucous membrane, such, for instance, as a vaginal or urethral electrode, should be immersed in pure carbolic acid or in pure crethol, benetol or lysol, be-

fore again using, if it has been in contact with the discharge from a specific disease.

In cases such as acne, psoriasis, eczema, neuralgia, non-specific diseases of the urethra, rectum or vagina, etc., it will suffice if the tube is immersed for a few moments or kept permanently when not in use, in a strong solution of any one of the three antiseptics mentioned in the preceding paragraph.

For this purpose a glass jar, large enough to take in the various electrodes, should be filled with a twenty per cent solution of carbolic acid (a five per cent solution is not enough); or as its equivalent, one of crethol, benetol or lysol containing a tablespoonful of either to the pint of water.

An ideal way would be to have two jars, one containing the full strength antiseptic, for the tubes employed in infectious cases, and the other for those used in non-contagious diseases.

Personally I prefer crethol or lysol to carbolic acid, because equally satisfactory and not caustic if any of the full strength liquid accidentally comes in contact with the operator's hands.

If the tubes are immersed in the pure antiseptic they should be thoroughly rinsed in alcohol and water, or in water alone before using. From the weaker solutions, water alone is necessary, but in both cases hot water is preferable.

The conveniences of most of our modern office buildings make the technique of sterilizing the tubes a simple one in the large cities, but in smaller towns the physician will find it somewhat more of a task.

In the absence of large jars to keep the two solutions in, with the tubes constantly immersed, wide-mouthed bottles may be employed for use before and after each treatment.

By sterilizing in this manner both before and after, the tube not only receives a double sterilization, but also if it has been taken care of immediately after use, if such a thing should happen that it should be used again without remembering about sterilizing it, the danger would be slight, and furthermore the tube is easier sterilized immediately after using, than it is when the secretions or discharges have dried upon it.

I have spoken of using the same care that you would with a surgical instrument, although the danger with these tubes is not as great as with surgical instruments for several reasons. In the first place, they are not employed ordinarily in a fresh wound; secondly, the danger is in carrying infection from one patient to another and not the additional danger which accompanies a surgical operation, of infecting the wound from the individual as well, and finally, in the majority of the cases treated there is practically no serious danger of infection.

If one had a sufficient number of tubes it would be desirable to keep an individual tube for each patient, which was used for no other. Immersion in the weaker solutions referred to above and rinsing, or even ordinary cleanliness would be sufficient; but at the close of the course of treatments, before the tube was used for another case it then should receive vigorous and thorough sterilization, in proportion to the danger of infection involved in the case.

The sterilizer shown in Fig. 28 is an excellent one. A basin of formalin solution keeps the tubes always sterile.

Some of my readers may think I am devoting too much space to this subject, but it is an important one and my early surgical training has made me a "crank" on this point, and really, could you ever excuse yourself if through your carelessness you spread, say a specific infection, even in one single instance?

Measuring Dosage. One problem that confronts the physician who is beginning to use the high frequency, is a method of measuring dosage. There is no meter which will measure the output of the vacuum electrode, or in other words the unipolar current. For auto-condensation and for diathermy the hot-wire meter is used and proves relatively satisfactory. For the vacuum tube, in order to convey an idea that would apply, no matter what size or make of apparatus might be employed, I have made use of the length of spark which it is possible to draw from the vacuum tube as a simple method

of giving some idea of the strength of current employed. This is a very crude method, and open to some serious objections, but will answer the purpose in a general way and convey a more intelligent idea than any method other than a meter.

With a definite amount of current passing through the apparatus, there is a positive point near the tube that represents its utmost sparking distance, that is, the longest spark that can be drawn from that tube, and this will remain constant as long as the current is constant—lessening the current shortens the spark; increasing it, lengthens it. Therefore, if I say I employ for skin diseases a tube capable of yielding a one-quarter inch or one-half inch spark, I give to the physician a definite idea of the amount of current I would employ in the tube.

This does not take into consideration the sharpness of the spark which must be adjusted in accordance with individual susceptibility and the type of machine used.

With the Tesla type of apparatus and particularly with small machines, the spark is apt to be sharper in proportion, and is designated frequently as a

"hot" spark. With these outfits it is often impossible to employ a spark more than a quarter of an inch in length. With other types, a longer spark will be tolerated, and with the Oudin type of apparatus we have what may be called a "cold" spark, and frequently one three-quarters or an inch long may be more easily borne than a quarter-inch "hot" spark. The cold spark is dehydratory and the hot spark caustic. In interpreting my suggestions for dosage in Chapter VIII, these facts should be taken into consideration. Ordinarily if the dose is given one-fourth to one-half inch the first would be for the "hot" and the second for the "cold" spark.

The Eberhart. Author's Unit of Measurement for Auto-Condensation. For a long time both physicians and manufacturers have felt the need of a standard unit for measuring auto-condensation; one that would fairly represent the auto-condensation output of any type of machine. I believe I have solved this problem, and have a standard of measurement that will prove acceptable to the manufacturers of any form of apparatus. It will be found convenient for the manufacturer to state with the directions for auto-condensation that the output of the machine is so many Eberharts per minute to each 100 milliamperes registered on the hot-wire meter. In this way with the dosage given as a certain number of Eberharts, it is easy to note by the meter how many Eberharts are passing per minute and by noting how many times this number will go in the total dose stated the number of minutes required for the treatment is ascertained.

There are three essential elements entering into auto-condensation. First the pressure or potential (voltage), second the rate of meter reading (amperage); and third, the time. When the voltage is high the amperage is correspondingly low and vice versa. In a general way the effectiveness of any machine for auto-condensation may be expressed in terms representing the product of the voltage and the meter reading (equivalent of amperage.) Thus 50,000 volts at 500 is the same as 25,000 volts at 1,000; each representing an auto-condensation effectiveness of 25,000,000.

My unit of measurement for auto-condensation is based on the passage of 1,000 volts at a rate of 100 milliamperes in one minute of time. This unit I call **the Eberhart** and abbreviate it E.

We have two types of apparatus for auto-condensation, the one high voltage and comparatively low amperage; the other low voltage and high amperage. In a general way I assume that the first represents a current of about 50,000 volts delivered at a rate of 350 to 500 milliamperes as shown on a hot-wire meter. The second averages 25,000 volts, potential, and is ordinarily delivered at a rate averaging 750 to 1,200; 1,000 being a frequent rate. Applying our unit it will be seen that 50,000 volts equal 50 E. for each 100 milliamperes meter reading, and if the meter read 500, there would be delivered 5 times 50 or 250 E. for each minute of time, and this would give 2,500 E. in a ten-minute treatment. With the other machine 25,000 volts equal 25 E. per 100, and with meter at 1,000 would give 10 times 25 E. or 250 E. per minute, or 2,500 E. would require a ten-minute treatment.

The manufacturer may state the voltage of his machine, if desired, but the simpler way is to give the number of Eberharts to each 100 milliamperes meter reading. He should also state the average meter reading at which the apparatus is to be operated. If he states the voltage, to compute a required dose, multiply the meter reading by the number of thousand volts, and divide this product by 100. This is the number of Eberhart units being given per minute and by dividing the dose as given in Eberharts by this, we have the number of minutes required. Going back to our previous example: to give 2,500 E. auto-condensation on a machine of 50,000 volts with enough current passing to raise meter to 500, multiply number of thousand volts, 50 by meter reading 500, and product is 25,000. Divide by 100 which is done by cutting off two ciphers and we have 250, which is the number of Eberharts per minute—250 goes into 2,500 ten times, therefore it takes ten minutes to give the required dose of 2,500 E.

It will be seen that it would be much simpler if

the manufacturer stated with this machine that the auto-condensation output was 50 Eberharts per minute for each 100 milliamperes registered by the meter. Then if the dose to be given is 2,500 E. and the meter registers 500, or five times the 100 rate, it is easy to figure then that 500 is five times 50 or 250 E., and this goes in 2,500 ten times, therefore it takes ten minutes to give that amount.

With the other type of machine we will say that the output is 25 E. per minute per 100 milliamperes; but this machine will ordinarily be operated at about 1,000 milliamperes, or ten times 100, therefore it is also delivering ten times 25 E. or 250 E. per minute and it will also take ten minutes to give 2,500 E. In Chapter VIII the dosage of auto-condensation will be stated in Eberharts.

It is well to remember that there is essentially no danger in auto-condensation and therefore no over-dose, so that the dosage stated may be greatly increased if results are not obtained.

The only cases in which caution is necessary, are those where a patient is carrying a high temperature or where the pulse pressure is 20 or lower.

Preparation of Patient. When the surface of the body is to be treated, the question of removing the clothing arises. If no spark is desired, the electrode must be in contact with the skin, and any clothing covering the part must be removed.

All metal, such as chains, corset-steels, wire hair-pins, etc., with which the tube comes in contact or within sparking distance of, will be charged with the current and give rise to sharp and disagreeable sensations. If they cannot be avoided they should be removed.

Applications to the body, calling for a mild spark, may be given through thin underclothing, or the patient stripped and covered with a sheet, through which the spark is employed.

Aside from the reason spoken of above (chains, etc.), when a sharp spark is required there is no especial need of removing the clothing, in fact, a definite thickness insures a definite length of spark.

When the tube sticks on the skin, dust on talcum powder or lay over the surface a very thin cloth, such as a handkerchief. In vaginal treatments no disrobing is necessary.

General Technique in Skin Diseases and Surface Lesions. In applying the high frequency spark over the surface of the body, as in acne, eczema, etc., I employ a current of sufficient strength to produce a spark one-quarter to three-quarters of an inch in length. The discharge from the smaller Tesla coils is relatively sharper than from the resonator or larger Tesla outfits, and a shorter spark is used as the patient cannot tolerate quite as much current in these instances. With a vacuum electrode capable of delivering a spark of the length given, I do not try to make use of the full length spark, but keep the tube in light contact with the skin, thus giving a sufficient intensity of current but avoiding the pain that would result if the tube were held at full sparking distance from the surface. The tube is passed rapidly back and forth over the area treated, and this will be accomplished in the easiest manner by holding the tube handle lightly with the fingers with the thumb extended along the handle. A side to side motion with the wrist will soon become a matter of habit to the operator and the tube

will pass lightly over the surface without any sudden jerks or elevations to cause annoying sparks.

If the skin is moist and the tube sticks, it may be dusted with talcum or other dusting powder to obviate this difficulty. Another method is to place a thin cloth over the surface, which will enable the tube to be used smoothly and at the same time does not remove it far enough from the surface to make an unpleasant spark.

Where itching is marked, the tube is raised from the skin and as sharp a spark applied as the patient will tolerate for a short period of time. This quickly relieves the itching, and also quickly produces the characteristic reaction of the current (hyperemia, etc.).

In treating epitheliomas, lupus and any chronic ulcers, a spark is employed in the same manner, that is, a sharp as the patient can stand, but not for a long period, say from two to three up to occasionally five minutes. Unless cauterization is sought, the tube should be kept moving rapidly over the surface and not allowed to expend its full effect steadily over any minute area. At the present time

fulguration (caustic) would be employed more frequently for epithelioma and lupus.

Technique for Relief of Pain. In congestive headaches, neuralgias and other painful conditions, the beneficial action of the high frequency current seems to be largely the result of counter-irritation. Therefore, it makes very little difference whether a sharp spark is used with the rapidly moving tube at full sparking distance, or whether with the same intensity of current, the tube is kept in contact with the skin. It depends upon the sensitiveness of the patient and also upon the location of the area treated. A long sharp spark occasionally exerts a slight caustic effect, and the surface will be covered with tiny blebs, which are followed by minute scabs, making the skin sore and uncomfortable. Unless the case to be treated is a severe one, it is not permissible to push the treatment to this degree.

Cauterization. If a hot spark is held steadily over the spot for from thirty seconds, up to two or three minutes, varying with the patient, it will have a cauterizing effect. The reaction is severe and the destruction of the tissue may be carried

to a marked degree. Such applications have been used in the treatment of warts, moles, etc.

I have treated epitheliomas in this manner and have had them separate from the surrounding tissue and peel out as smoothly as if cut out with a die. It is too severe a measure, however, for the average case. Fulguration involves the same principles, and is preferable. The spark is derived from a metal point and anesthesia may be employed if desired. The technique of this will be considered in another section.

Orificial Technique. The technique of the application to the orifices of the body involves the use of tubes suited to the various areas, and also involves the question of sterilization and lubrication. In these cases the tube is in contact with the mucous membrane and there is no sensation to the treatment except usually that of warmth. There is in these cases greater danger of producing burns, and the tube should seldom be left in contact for a longer period than seven minutes at any single treatment. (See the section on vacuum tube burns in Chapter V.) The technique is so peculiarly that

of the special organ involved that it will be given under its appropriate heading in Chapter VII. It is desirable to remember that tubes should always be inserted before the current is turned on, and the latter turned off again before the tube is removed, thus avoiding all pain and shock to the patient.

Cataphoresis. For cataphoresis a special electrode is employed. See Fig. 29. The substance to be carried into the tissues is in solution, and cotton gauze or felt wet in the solution is placed in the depression on the face of the tube when the latter is placed in contact with the desired area and the current passes for from five to ten minutes or more as required. I caution against the use of solutions containing alcohol or other inflammable substance because of the danger of setting same afire with the current.

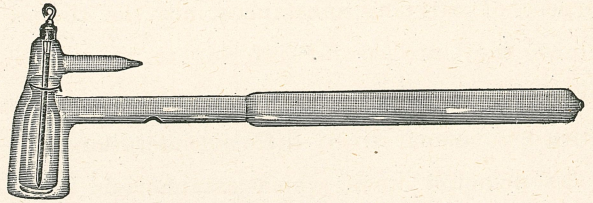


Fig. 29—Cataphoresis Electrode.

In one form an insulating ring prevents loss of current and is a great improvement on the older style of tube.

See Chapter XII for special electrodes used by dentists.

Although strong claims have been made concerning the value of high frequency currents for the purpose of carrying substances into the tissues, I believe they are so far inferior to the galvanic current for use for these purposes that they are entitled to comparatively little consideration.

The principle upon which cataphoresis depends is the separating of the particles (ions) composing the fluid by reason of the attraction possessed for them by poles of the battery; thus all positive elements remain at or are drawn through the tissues toward the negative pole, and vice-versa. Now, in using high frequency currents, which are alternating, the attraction would be first in one direction and then in the other, and as a result practically nothing would be accomplished.

The claim is made that the high frequency current drives substances into the tissues by "molecular bombardment." I maintain, however, that the cataphoric action of the high frequency current is too feeble to commend it for general use, for which purpose nothing takes the place of the galvanic current.

Bi-polar Tesla Technique. Ordinarily the vacuum tube is attached to one pole of the Tesla outfit. In some coils the sharpness of the spark is regulated by drawing off a certain amount of the current from the active pole by bringing the sparking rod near it, thus lessening the available current.

If it is desired to intensify the action of the Tesla coil, the indifferent pole should be attached to the patient or grounded by connecting to a gas or water pipe.

Selection of Most Suitable Form to Use. Where a local effect is more essential, vacuum tubes, metal electrodes, etc., are employed, but if a systemic or constitutional effect is desired, auto-condensation is to be selected, or the diathermic treatment may be used.

2. FULGURATION.

Fulguration. A long, sharp spark for escharotic or destructive purposes was employed for a long time by high frequency operators, but the use of a metal electrode devised by Keating-Hart for this purpose, which he termed fulguration, gave an unusual impetus to the method.

Fulguration as employed at the present time may be considered under two forms: 1. **Caustic or hot fulguration,** employed with D'Arsonval or Tesla apparatus, and giving a hot, caustic, or cauterizing spark. The D'Arsonval fulguration is particularly suitable in orificial work, such as papilloma of the bladder, etc. The Tesla is especially advantageous in surface work, such as moles, warts and other superficial growths.

2. **Dehydratory or cold fulguration,** employed with Oudin apparatus. The destruction of tissue is through a drying process and there is no sloughing. There is essentially no pain, but its range is necessarily limited.

Fig. 30—An Outfit Combining High Frequency with Numerous Other Modalities, Twenty-one in All.

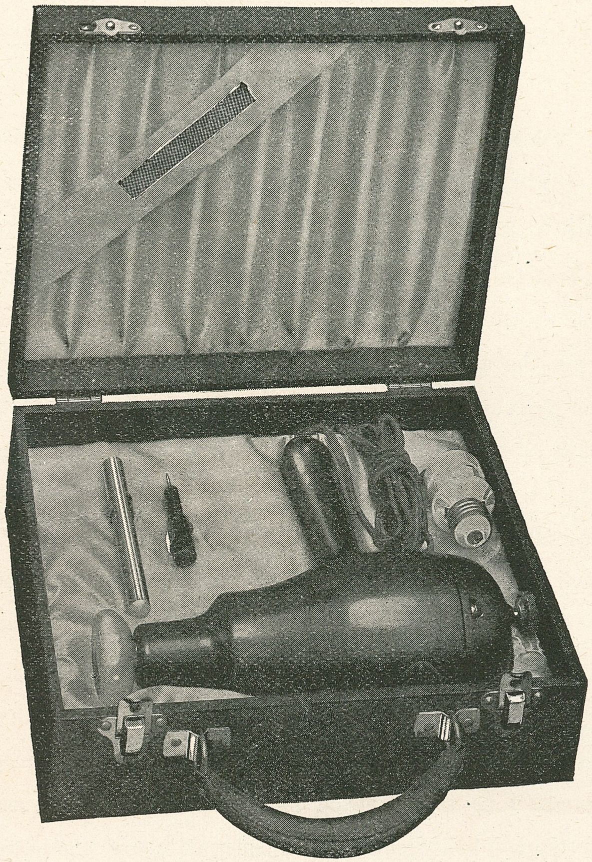


Fig. 31—A Novel Outfit with Coil, Resembling a Portable Vibrator in Form.

Dr. W. F. Clark of Philadelphia employs a method of cold fulguration with the static machine, to which he has applied the term dessication.

General Caustic Fulguration. The technique which I employ for warts, moles and small growths is as follows:

The fulguration electrode is attached and the current turned on gradually, while the length of spark from the metal point (Fig. 33), is tested by bringing the point nearly in contact with a piece of metal, such as a coin. Without an anaesthetic it is impossible to employ one more than one-thirty-second to one-eighth or occasionally three-sixteenths of an inch in length. This spark is hot, and actually sears or burns the tissue, as noted by the eye and usually by the odor.

It is not desirable to keep this spark in steady contact, as it is too painful, but if the point is touched to the surface and quickly brought away beyond sparking distance, the patient is better able to stand it, and by a series of rapid sparks produced by a tapping motion of the point, thorough fulgura-

tion may be achieved without unbearable pain to the patient. Ordinarily I pass around the margin of the growth first, and then fulgurate the center. It should be done thoroughly, and the growth will pre-

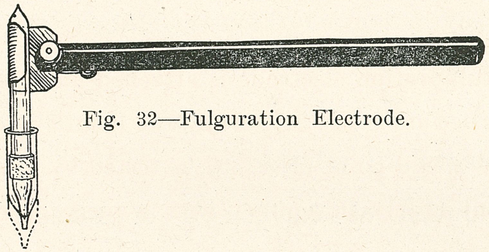


Fig. 32—Fulguration Electrode.

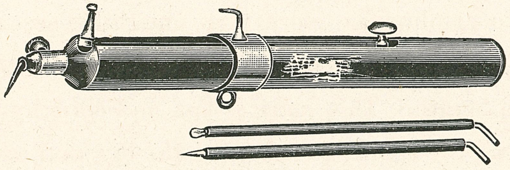


Fig. 33—Fulguration Electrode.

sent a brown, burned appearance. There is seldom any hemorrhage, but usually some serous oozing. A crust or scab forms which separates in a week or ten days (average eight), leaving no scar. It is well to bear in mind that if you do not get it all off the first time you can fulgurate again, but if

you remove too much you cannot place it back again.

For more extensive work, local or general anaesthesia is necessary.

It is fair to state that very satisfactory caustic (hot) fulguration may be accomplished with small machines.

In papillomata of the bladder, fulguration has been particularly valuable.

Fulguration of Papillomata of Bladder. The author strongly advises the use of the D'Arsonval current (bi-polar method) in preference to the Tesla or Oudin currents. One terminal of the apparatus is connected to the fulguration wire, which is passed through the cystoscope, and the other terminal is connected to an indifferent flat metallic electrode placed on the abdomen. The fulguration wire or electrode consists of a steel wire insulated with pure gutta-percha. As this wire is to be passed through the channel of an ordinary catheterizing cystoscope, it should not be larger in gauge than No. 6 French.

The patient is prepared with green soap and water and bichlorid, and the bladder distended with water. After the cystoscope is introduced, the tumor is brought into view and the fulguration wire passed through the catheter channel of the cystoscope until the end of the wire is in view. The wire is then plunged into the tumor and the current turned on. (Before introducing the wire into the cystoscope, cut the wire so that the insulation is flush with the end of the wire.) Just as soon as the high frequency current is turned on, bubbles (presumably hydrogen) are seen emanating from the tumor. If the tumor is small, or the electrode has been placed near the top of the tumor, an immediate blanching of the tumor is seen. This treatment can readily be carried out under the guidance of the eye, providing the insulation of the fulguration wire is intact; unless the insulation is intact, a short-circuit in the cystoscope and subsequent burning out of the cystoscopic lamp may result.

After allowing the current to pass into the tumor for about twelve to fifteen seconds, the current is

shut off, the fulguration wire withdrawn and reapplied to another part of the tumor. In large tumors, this procedure can be repeated until many different areas of the tumor have been treated in one sitting. As long as five or six minutes may be consumed in one sitting. Naturally, the duration of each treatment will depend on the size of the tumor. For example, in one case, one sitting consisting of three 12-second applications was enough to completely destroy a small papilloma.

As long as the intra-vesical electrode remains in contact with the tumor no pain is experienced by the patient. When working near the base of the tumor, or if the electrode comes in contact with the bladder-wall, the patient frequently complains of pain. So that during the first fulgurations there is no pain, whereas, toward the end of the treatment, while working near the bladder in treating the remaining tags, the patient at times complains of pain. It is also necessary to consider the pain incident to cystoscopy. This is variable in different persons, so that some of the patients cannot tolerate long sessions as well as others. The number of

treatments or sittings, as previously stated, is determined by the size of the tumor, some cases requiring as many as six sittings.

Attention is called to the burning off of the insulation near the end of the fulguration wire. After the current has been turned on and the treatment carried on for a little while, sometimes only ten seconds, the insulation becomes soft and falls off or burns off from the end of the wire, so that it becomes necessary to withdraw the wire and cut the end off squarely. Unless this is done, there is danger of the bare wire causing a short-circuit in the cystoscope.

Usually when the high frequency current is applied the tissues become white and shrivel up. Sometimes the tumor surface appears dark, as though it were baked. Not infrequently after an application a larger or smaller piece of the tumor adheres to the end of the fulguration wire. At other times these small pieces may be passed at the next urination, and often they are obtained from the washwater. These are carefully saved and examined microscopically.

It is suggested that papillomata should be considered malignant in all cases; that in all cases of long standing cystitis which has persisted even in the presence of careful treatment, or with the history of frequent relapses, papilloma should be suspected, and the diagnosis confirmed or contradicted by cystoscopy. It is the consensus of opinion that the fulguration method is followed by remarkable results, but as yet sufficient time has not elapsed for us to make a definite statement as to an absolute guarantee that this treatment will prevent recurrences. (Abstracted from an original article, "Fulguration Treatment of Bladder Tumors," by Herman L. Kretschmer, M. D., of Chicago. Illinois Medical Journal, April, 1913.)

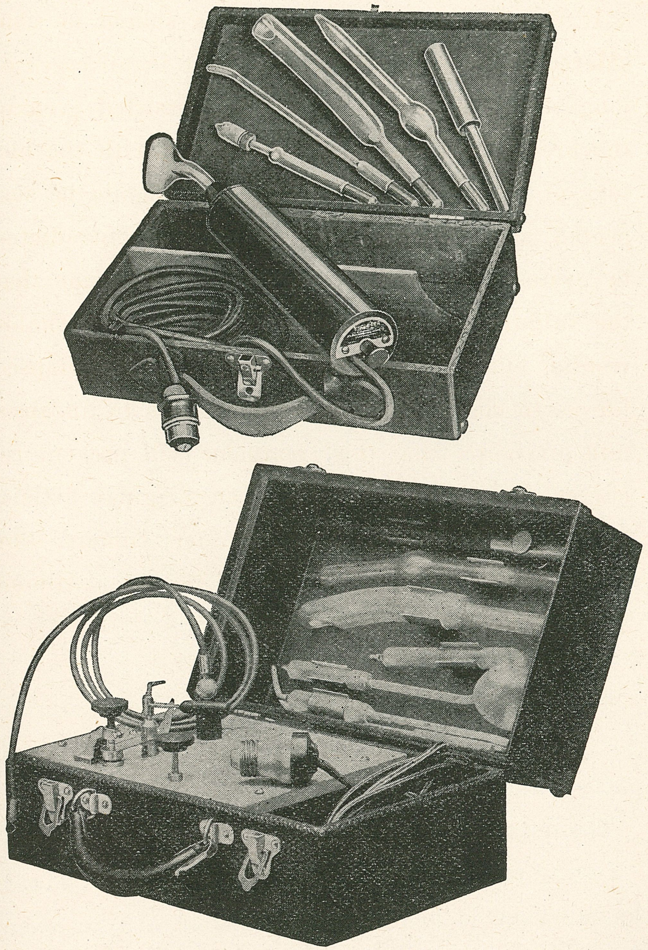


Fig. 4—Two Portable Outfits.

3. CONSTITUTIONAL (AUTO-CONDENSATION AND AUTO-CONDUCTION).

Auto-conduction. In auto-conduction the patient is placed within a large solenoid or coil, constituting a cage. The patient is not in contact with this cage at any point and the high frequency currents in the patient's body are produced by conduction.

The cages are of several types, some in perpendicular form, and others in a horizontal position. In the latter the patient is either placed on a board which slides into the cage, or the top of the latter is hinged like the cover of a basket. Some of the perpendicular forms are collapsible, others are fitted with a door, the patient standing or sitting on a stool.

Small cages are also made into which the arm or leg may be introduced, thus producing localized auto-conduction effects.

The dosage is the same as with auto-condensation.

Owing to an inherent objection on the part of the human race to being incarcerated in a cage, even for a short time, this method of treatment, although

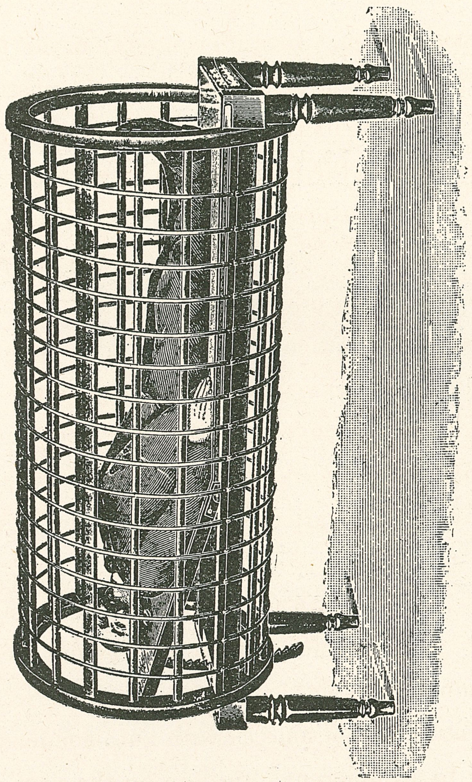


Fig. 35. Horizontal Auto-Conduction Cage.

excellent in results, is used comparatively little at the present time; furthermore, it has no advantage over auto-condensation.

Auto-condensation. In auto-condensation, one of the terminals of the apparatus is attached to the metal forming one plate of a condenser and the

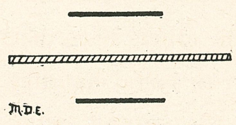


Fig. 36.

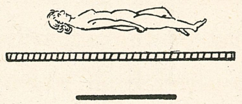


Fig. 37.

other to the patient, who becomes in this manner the other condenser plate.

The patient is insulated from the metal plate by silk floss, rubber, mica, glass, or other form of dielectric.

In Figure 36 is shown a cross-section of a plate condenser. In Figure 37 the body of a woman is substituted for the upper plate, thus showing the principle involved in auto-condensation.

Auto-condensation is administered by means of

a couch or pad designed for the purpose and may include the whole body or be constructed to influence only a part of it.

The original couch was in a form similar to that of a Morris chair (Fig. 38), the plates of zinc being under the cushions on back and seat, the cushions themselves being stuffed with silk floss or with Spanish moss. The plates connect with one binding post of the apparatus, and the other is connected to a rod from which wires run to metal handles on each side, which are held by the patient, who receives the charge whether one or both handles are grasped.

In that part of the circuit that is connected to the handles a hot wire meter is placed to measure the dosage. No other form of electrical treatment gives so high an amperage, except diathermy, the dose running from 150 to 1,500 milliamperes, with occasional reports of the use of even a stronger dose.

It is well to remember that there are two types of machines used in producing auto-condensation. One has high voltage, but comparatively low amperage, requires a cushion at least three inches thick

and has great penetration, so that a vacuum tube will light up within an area of several feet surrounding the patient. With this type the average meter reading to obtain satisfactory results is 350 to 500. It is seldom necessary or desirable to secure a higher reading. Lower readings, 150 to 200, would be used where it was desired to influence nutrition without particularly lowering blood-pressure.

The other type machine has comparatively low voltage, but high amperage. It may be used with a thin pad if desired. The meter will read 750 to 1,000 on an average, and up to 1,200 or 1,500, according to the potential of the apparatus. Auto-condensation is measured in Eberharts, as stated in a preceding section in this chapter.

As long as the patient is in electrical contact with the handles, that is, perfect contact, no sensation is felt except occasionally a slight tingling or sensation of warmth. Sparks may be drawn from the patient, and these may be quite painful. In type No. 1 a vacuum tube held in operator's hand will draw a spark from patient which is known as one form of indirect spark. In general, a feeling of

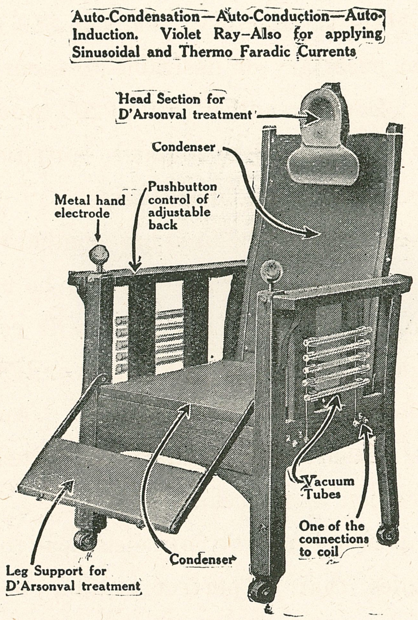


Fig. 37a—A High Frequency Treatment Chair.

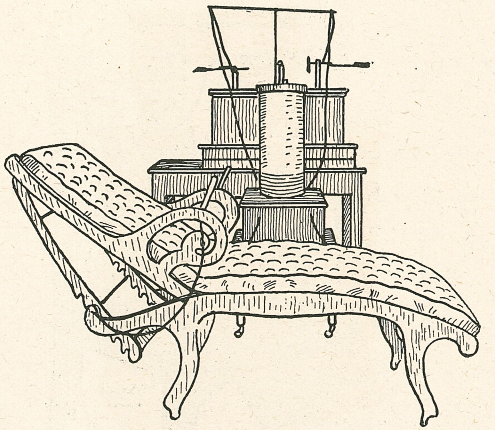


Fig. 38—Auto-Condensation Couch with Oudin Resonator and Induction Coil. Original Type.

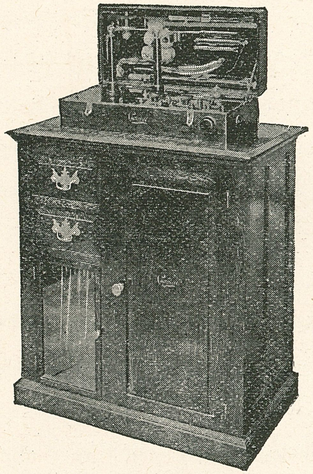


Fig. 38a—Portable Outfit and Cabinet.

warmth pervades the body after a few moments, and the temperature is shown by the clinical thermometer to be from one-half to one degree higher than before the treatment.

The couch or cushion is connected to one terminal of the apparatus, the patient to the other. The static machine with hyper-static transformer does not give a sufficient amperage for the satisfactory operation of a couch; neither does the average portable outfit, although the latter has more amperage than the static machine. Both of these may be used for charging small pads for restricted areas, and some types of the larger portable coils I have found capable of operating a good-sized pad, if the di-electric is thin.

In 1903 I designed the first portable body pad, which folded together when not in use. It consisted essentially of the top of the couch and was intended to save the space required for the latter.

About the same time Piffard produced a condenser pad for the seat of an ordinary chair (Fig. 41).

It is a well-known fact that the thinner the di-electric is, as long as it is a perfect di-electric, the

greater the corresponding charge that may be held on each layer of condenser. This caused me to substitute flexible mica for the material used in the ordinary pad and thus produce a portable auto-condensation pad only half an inch thick, and capable of being slipped under the leather cushion of the ordinary office treatment table, converting the latter into an auto-condensation table. At the same time a much greater charge of electricity may be condensed in the patient than with the thicker pads.

Pads less than three inches thick have been condemned by the standardization committee of the American Electro-therapeutic Association, therefore, at the present time I employ only the thick cushion.

Many ingenious operators construct their own chair or couch, and from an article of mine on this subject in Popular Electricity, November, 1909, I make a few excerpts:

"A glass slab, four or five feet in length, twenty inches wide and about one inch thick, such as is used in a glass-topped operating table, is fitted in a wooden frame and to the under surface is attached a strip of zinc or of sheet lead 1/32 of an inch

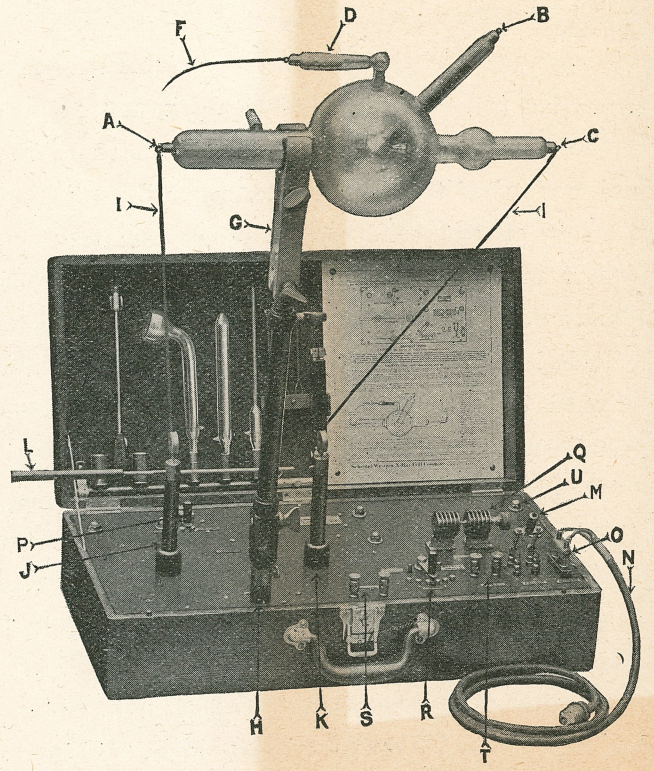


Fig. 39—Portable Coil.

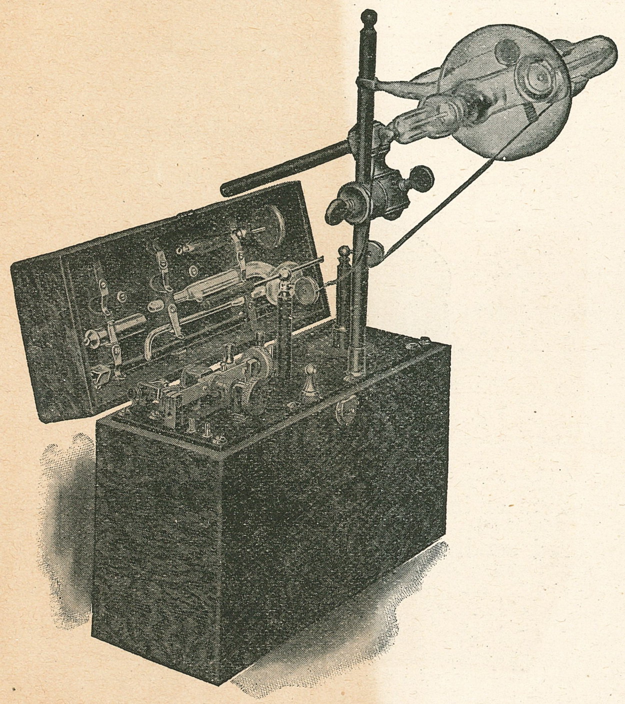


Fig. 40—Portable Coil.

thick. This strip should be about ten or twelve inches wide, so that when placed on the lower surface of the glass it will leave a margin of about four or five inches between the edge of the zinc and the edge of the glass. It should extend lengthwise to within six inches of either end of the glass slab.

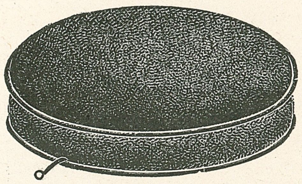


Fig. 41—Condenser Cushion for Chair.

The zinc or lead plate is connected by an ordinary covered conducting wire (say, not smaller than No. 10 or 12), to one pole of the high frequency apparatus and the patient connected by an ordinary metal electrode to the other pole. The patient may be placed directly on the glass, but it is preferable to place him on a thin cushion upon the glass, for the sake of comfort.

"Another method is to take a wooden table long

enough for the patient to lie on and place underneath the table top a layer of plate glass the full size of the top of the table with a strip of lead or zinc attached to the under surface of this glass, always bearing in mind that the essentials of an auto-condensation pad are to have a di-electric with a layer of condenser below it, and the patient attached to the apparatus to form the upper layer. Thus, an ordinary Morris chair or steamer-chair may be used and a layer of lead or zinc fastened underneath the back and seat of the chair, the two strips being fastened together with metallic connections (chain or wire) and underneath the ordinary cushion of the chair, four or five layers of rubber are placed to serve as the di-electric, although the cushions themselves, if they remove the body beyond the sparking distance of the charge on the zinc plate, would really make the air space intervening serve as a di-electric. This is not as satisfactory as when the layers of rubber are placed between. The patient then is connected by the ordinary metallic hand electrode and conducting cord or metallic handles may be fastened on the arms of the chair,

the two connected by a bifurcated conducting cord to the one pole, the zinc plates to the other.

"Lastly, a pad may be constructed on the same plan as the one which I have designed, using one or more layers of sheet mica large enough to permit the body of the patient to rest on and making use of a layer of condenser (either lead or zinc) underneath the mica, taking care that it does not extend near enough to the edge of the mica to allow the charge to leak over. On top of the mica place three or four layers of felt or cover with leather as desired. Should the mica be insufficient to prevent some sparking through, it may be obviated by placing another thin cushion on top of this pad."

The patient is placed on the couch or pad and con nected to the apparatus before the current is turned on, and then the current turned off before the patient lets go of the handles, thus avoiding all shock.

If the patient questions whether he is getting any current or not a few sparks drawn from his body readily convinces him.

Another form of treatment which the patient feels to the extent of strong muscular contractions may

be made by introducing a spark-gap itno the patient's circuit. This I describe in another section as D'Arsonval surgings.

The value of auto-condensation depends upon its remarkable effect upon general metabolism (see Chapter V). In nearly all cases of hypertension the blood-pressure is lowered.

Auto-condensation treatments average ten to thirty minutes in duration (2,500 to 7,500 Eberharts), and should be given daily, or six times a week at first, in nearly all cases, gradually decreasing as improvement takes place. Less than three treatments per week at the start are, in my opinion, practically useless. Longer treatment may be given if the physician desires.

Cautions. There is practically no danger of an over-dose of auto-condensation, the only danger being in cases where the patient has a high temperature that will be raised still higher, where a small dose, if any, is given, and in case of a pulse pressure below 20. See section Taking the Blood Pressure, and under Arterio-sclerosis, Chapter VIII. In low

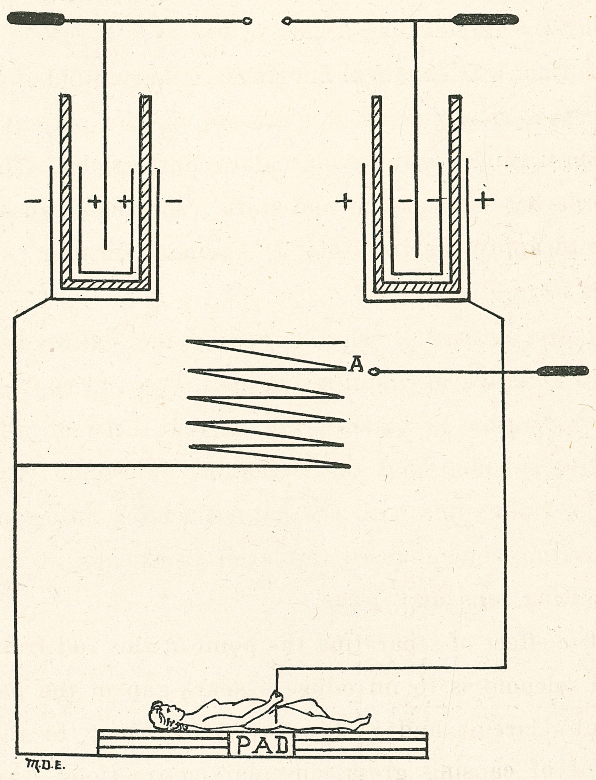


Fig. 42—Author's D'Arsonval Surgings. Separating the Sliding Rod at A or Introducing a Spark-Gap Anywhere Between A and the Patient, Produces This Effect.

pulse pressure there is danger of obliterating the pulse by auto-condensation.

Author's D'Arsonval Surgings. I have alluded to the fact that placing a spark-gap in the patient's circuit causes strong muscular contractions. The similarity between this and static "surging" caused me to apply the term of "D'Arsonval surging" to this form of treatment.

I first noticed it when adjusting the sliding rod on a D'Arsonval-Oudin resonator. This rod enables the operator to balance the current between the coarse solenoid and the resonator, or "tune" the coil. Doing this with the patient on the auto-condensation couch caused the latter to exclaim at the resulting muscular jerks.

The effect of separating the point of this rod from the solenoid is to introduce a spark-gap in the patient's circuit and to lower the frequency to the point of causing gross muscular contractions. An outline of the method is shown in Fig. 42.

It really is in line with the original experiments of D'Arsonval, who first doubled the number of solenoids, thus producing auto-conduction; then

doubled the condensers, as in auto-condensation; and now this form doubles the spark-gap, the only remaining element employed in the D'Arsonval circuit.

High Frequency Water Spray. V. Laughter has devised an ingenious method of connecting the high frequency current to hydro-therapeutic apparatus in such a manner that the stream or spray of water emerging from the latter is charged with the current and when this strikes the body of the patient he receives the effect of the high frequency current as well as that of the water.

Local Auto-Condensation. The "Plate Glass Method." Various methods have been devised for applying auto-condensation locally over small areas. Sheets of rubber with a pocket in which to slip a flat lead or zinc plate are one form. A very popular way, known as the "plate-glass" method, consists in using as an electrode a metal point or ball and applying the sparks through thick plate glass held in contact with the patient's body. The glass is the di-electric, the electrode corresponds to one

plate of a condenser, and the surface of the body next to the glass to the other.

Indirect Sparks. If a resonator is connected directly to a patient with a metallic electrode and a vacuum tube is then brought near the patient's body sparks will fly from the latter to the tube. These are called indirect sparks. See Figure 43.

Attaching the patient in a similar manner to one pole of the Tesla coil, while the tube held by the perator is grounded by connecting to water pipe or gas jet, accomplishes the same result.

Another method of deriving an indirect spark and one with which I have been experimenting considerably during the past two years is obtained from the patient when lying on the auto-condensation pad.

I use a high-voltage, low-amperage type of machine with a thick pad. Enough current is turned on to give a meter reading of about 250 (125 E.). A vacuum electrode is held in the operator's hand and the length and strength of spark tested by touching the metal handle which the patient is holding, before the tube is applied to the patient's body. The current is then raised or lowered to pro-

vide a suitable intensity and length of spark, after which the electrode is applied to the portion of the body to be treated. The spark is drawn from the patient's body, is disruptive in character, and is particularly suitable for various skin diseases, having also the advantage of the patient's nutrition and general metabolism being benefited by the auto-condensation which accompanies it. In other words, it is both local and general in its effects

Taking the Blood Pressure. As a knowledge of the patient's blood pressure is vitally necessary to the physician using high frequency currents it is important that he should have an instrument for its rapid and accurate determination. The instrument used for this purpose is called a sphygmomanometer and a number of satisfactory machines are on the market. The diaphragm type is shown in Figs. 44 and 44b.

The mercury type is shown in Fig. 44a. Its action depends on opposing the pressure of a column of mercury with the pressure of the blood in an artery. For this purpose the brachial artery, in the arm above the elbow, is selected.

A cuff or band containing a rubber sack is fastened around the arm above the elbow, with that part from which the rubber tube emerges lying in front over the artery. Ordinarily the sleeve is rolled up before the band is applied, but if the clothing it thin this is unnecessary. A small rubber hose runs from the cuff to the machine, which has a U-shaped tube containing mercury, with a gauge between. The zero mark on the scale is placed on a level with the top of the mercury.

A rubber bulb is attached by a small tube to the machine, and the physician holds this bulb in one hand, while with the other he keeps a finger on the pulse in the patient's rist. The bulb is now compressed and immediately air fills the cuff and the column of mercury begins to rise. The operator continues to slowly inflate the cuff until the pressure of the latter shuts off the blood in the brachial artery and the pulse can no longer be felt at the wrist. When this occurs the pressure of the column of mercury has balanced the pressure of the blood in the artery and the reading on the scale opposite the top of the column is the patient's blood pressure.

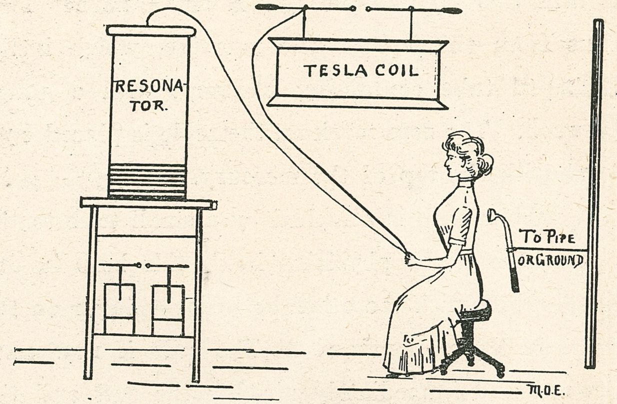


Fig. 43—Indirect Sparks.

Fig. 44—Taking Blood Pressure with Diaphragm Type of Sphygmomanometer.

Fig. 44a—Taking Blood Pressure with Mercury Sphygmomanometer.

In using the instrument it is customary to force the mercury a little above the point where the pulse ceases to be felt and then wait two or three seconds until the column settles to the point of the reappearance of the pulse. By doing this one, two, or three times an absolutely accurate reading may be depended on.

The scale reads from 0 to 300 The normal is 120. The numbers refer to millimeters of mercury. A variation of 10 millimeters up or down would not necessarily imply abnormal pressure, but 140 or more would be presumptive of the presence of or tendency to arteriosclerosis.

Another instrument for accurately determining blood pressure is the tycos diaphragm type of instrument, shown in Fig. 44.

This is not a mercury instrument, but the readings are obtained by indirect, internal pressure on sensitive diaphragm chambers, so sensitive indeed that every action of the heart is shown plainly by the hand on the dial, as the hand works co-incidently with the heart.

With this instrument the observer can accurately

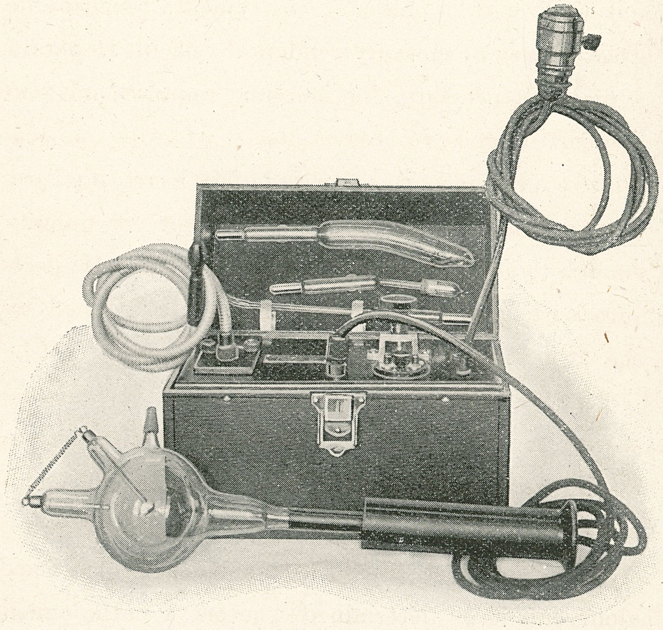


Fig. 44b—Portable Outfit with Novel X-Ray Tube for Surface Treatment.

determine complete blood pressure, by that we mean maximal or systolic; minimal or diastolic, and **pulse pressure** (the difference between the two). This is not easy with a mercury instrument, because the great inertia of mercury renders it difficult to obtain a diastolic pressure, for mercury requires one and one-half seconds to recover itself, while in one second we have had one and one-fourth heart impulses, so you can see that mercury does not act quickly enough to accept the second impulse. Diastolic pressure with a mercury machine may be obtained by the auscultatory method described later on.

The minimal or diastolic pressure is fully as essential as the maximal or systolic, for without an exact diastolic to subtract from the systolic we cannot get the most important thing in blood pressure, that is the pulse pressure, for by pulse pressure alone can it be determined whether a pathological condition is compensated for or not.

The normal pulse pressure (difference between diastolic and systolic) should be from 20 to 55 millimeters.

The determining of pulse pressure by those using

the high frequency current is absolutely essential, for, as said before, by this we can tell whether a condition is compensated for, and whether the use of the high frequency current is indicated or contraindicated.

As an illustration, we will say that we have a case with a systolic pressure of 170, and a diastolic pressure of 140. This shows, by subtracting one from the other, that the pulse pressure is 30, therefore, normal. No matter then if the systolic be 170, for the pulse pressure being normal shows that the condition is compensated (or the pulse pressure could not be normal), and, therefore, a circulatory equilibrium is established, and in these cases any further reduction of systolic blood pressure must be accompanied by a corresponding decrease in diastolic pressure or compensation will be interfered with.

Of course, if the systolic was reduced to 160 and the diastolic remained 140, compensation would still exist, but would be at its low limit, and the patient would probably not be as comfortable as with 165 or 170, with 140 as the diastolic. If, however, under

auto-condensation both systolic and diastolic pressures decreased, if not always the same reduction, at least without the pulse pressure going below 20, the treatment may be persisted in until the systolic pressure is normal.

Whenever the pulse pressure reaches 20 and stays there, after carefully giving one to three additional treatments auto-condensation should be abandoned. It has been carried as far as it can be of benefit to the patient, no matter what the systolic pressure then may be, and I would suggest spinal sparks to raise it slightly, that pulse pressure may be at least 25.

Where the systolic reading is high it sometimes happens that the pulse pressure will, when auto-condensation is employed, drop to 20, or even 18, but after a few days the diastolic will reduce enough to give an increased pulse pressure, and thereafter both systolic and diastolic keep reducing in proportion, in which case the treatment is kept up. See further discussion and -examples under Arteriosclerosis, Chapter VIII.

There are two methods of determining blood pres-

sure with the tycos type, which I have taken from Dr. Cowing's book, "Blood Pressure Technique Simplified."

First, the method of oscillation.

Place the bag over the arm with the two tubes well under the arm and over the brachial artery. Wrap the remainder of the sleeve around the arm much the same as you would apply a bandage, tucking at least six inches of the sleeve under the last fold. Then place the sphygmomanometer in one tube and the bulb in another and you are ready for reading. Care should be taken not to put the sleeve on tight enough to cause any apprehensive feeling in the patient. Place the fingers lightly over the radial artery, and send the pressure in the cuff up to the point where the pulse disappears or is obliterated. This is the systolic or maximal reading.

It is desirable that the patient's wrist be supported from below by the palm of the doctor's hand, while the first and second fingers lie with their tips over the artery. Thus the weight of the hand is prevented from shutting off the pulse too soon.

Second, the method of auscultation. This is, by

far, the most practical method of accurately determining blood pressure, as the dangers of personal equation are greatly lessened. See Fig. 44c.

Bare the arm, adjust the sleeve well up (as above described), place the stethoscope over the brachial artery. Now gradually inflate the bag, and the

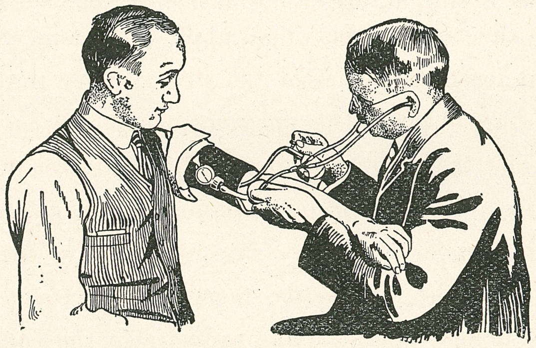


Fig. 44c—Auscultation Method.

first and second sounds of the heart will become audible. Increase the pressure in the bag to the point where all sounds cease. At this point will be the exact systolic or maximal pressure.

Having obtained this, gradually release the air by means of the valve, and the first and second sounds of the heart will become apparent, increasing in

volume as they approach the diastolic point, at which point the second sound will entirely disappear.

The above method cannot be employed where aortic insufficiency exists or where there is a dilatation of the vessels. These conditions being observed, when the pressure is first increased on the brachial, as soon as a slight pressure is placed on the artery, a pistol-shot tone is heard, and will continue with but little variation throughout the observation. When this condition exists it is absolutely necessary to resort to the oscillatory method. It is also necessary to use the method by oscillation when the pulse is feeble.

Having now accurately determined both systolic and diastolic pressure, we compute the pulse pressure.

Pulse pressure is obtained by subtracting the diastolic from the systolic, for example:

Systolic pressure, 120; diastolic pressure, 90; the difference, pulse pressure, 30, and, as previously stated, it should not be less than 20, and would also indicate a pathological condition as probable if over 55.

In about 7,000 cases Cowing obtained the following average normals:

Children from 10 to 17, 85 to 110 mm.
Adults from 21 to 40, 120 to 130 mm
Adults from 40 to 50, 120 to 135 mm.
Adults from 50 to 60, 135 to 145 mm.

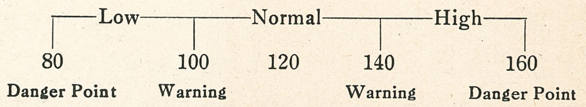
It is well to remember that there is an ever increasing hardening of the arteries as one grows older, and a person of 65 or over can very easily have a blood pressure of 160 and still be a comparatively healthy individual. At the same time if these changes were not taking place the blood pressure would remain the same, no matter what the age of the patient might be. Female pressure is 10 mm. lower than that of males Any blood pressures, however, between the ages of 21 and 50, lower than 100 or higher than 150, can safely be termed pathological cases.

Leading life insurance companies now insist on the examiner taking the blood pressure. Most of them reject applicants whose pressure is 160 or higher, whether any other reason is apparent or not;

just as they do where the pulse is persistently above 90.

An easy method of keeping the range of blood pressure in mind, which I have employed in my classes, is as follows:

Consider 120 the normal. At 20 above or below, that is 140 or 100, the warning signal is out, and at 20 more either way (160 or 80) the brink of the precipice has been reached and a pathological condition, and probably a dangerous one, exists.



It has been noted that enlargement of the heart or degeneration of the kidneys cause a comparatively high blood pressure and when both are present the pressure may be extraordinarily high, often (280-325), or higher than is provided for on many of the instrument scales.

One observer reports a study of the blood pressure in seventy men. At forty years of age the

average pressure was 115; at sixty it was 135, and at eighty it was 150.

Another physician found the average in 100 men to be a little over 118.

An increased determination of blood to the surface of the body lowers the pressure, and, conversely, driving the blood from the surface raises the blood pressure.

It is important that the sphygmomanometer be used, as in one series of 1,000 tests it was observed that abnormal pressure existed in many cases that a competent and experienced observer failed to detect without.

In taking the systolic pressure I have occasionally found that just as I had determined the pressure there would be a sudden increase, running up 5 to 20 millimeters. This I have concluded is due to a spasm of the artery, causing sudden contraction.

Miscellaneous Suggestions. When a resonator is employed in connection with an induction coil on the direct current and a mercury interrupter is used, if it is difficult or impossible to secure a steady spark in the spark-gap of the resonator, it is a sign

that the mercury in the interrupter is dirty and needs cleaning.

With this same apparatus, the spark may be made sharper by increasing the number of turns of wire in use in the coarse or primary coil of the resonator. This increases the size of the solenoid and consequently its induction This is true of any Oudin resonator having the sliding rod to regulate the size of the coarse coil.

When using vacuum tubes care should be exercised to prevent the connecting cord from touching the patient, as annoying sparks will result. It is almost impossible to find a cord so well insulated that the high frequency current will not soon find its way through.

Diathermy. The fourth division of my classification of technique involves the methods known under the several terms, electro-coagulation, thermopenetration, direct D'Arsonval current and diathermy. The method of employment is given in Chapter XI.

CHAPTER SEVEN.

Special Vacuum Electrode Technique for Various Parts of the Body, Including Ear, Eye, Nose, Rectum and Prostate, Scalp, Throat, Urethra and Vagnia.

In order to avoid unnecessary repetitions in Chapter VIII, where particular diseases are considered, the method of using vacuum electrodes in treating various portions of the body is given herein, together with an idea of the scope of the treatment in diseases of these organs.

Technique in Diseases of the Ear. In applying the current to the ear, as in catarrhal deafness, etc., a small vacuum electrode is employed, plain and insulated types of which are shown in Figs. 20 and 21. These are used most conveniently in the author's movable socket handle, which enables the patient to sit comfortably with the hands against the chest.

Fig. 4—Treating the Ear.

the tube placed at such an angle in the handle that it is easily inserted into the ear and the cord connecting to the apparatus hangs clear of the patient. See Fig. 45.

It is certainly a great improvement over the old method, which required the patient to hold the handle almost at arm's length.

The electrode is placed in the ear and the machine started with a minimum of current. The strength is then increased in accordance with the tolerance of the patient to the point where the buzzing sound becomes annoying, or the fine sparks become too sharp. With the insulated tube, the sparks coming from loose contact with the external opening are avoided. A marked sensation of heat is noticed in the ear, and the best method of regulating the length of treatment is to allow the tube to remain until this heat effect becomes a little uncomfortable, although I would never under any ordinary circumstances continue the treatment longer than seven minutes.

I designed a holder a few years ago which permitted treating both ears at the same time, but for

all ordinary conditions this is scarcely necessary, as the additional time required in treating the other ear where both require treatment is not sufficient to interfere seriously. The conditions of the ear in which high frequency currents give the best results are catarrhal deafness; earache; tinnitus aurium,

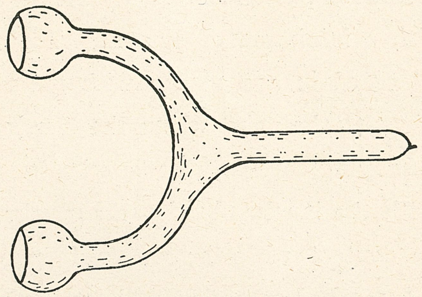


Fig. 46—Double Eye Electrode.

and chronic suppurative diseases (middle ear diseases).

Special Technique in Treating the Eyes. For applying high frequency currents to the eye, a double electrode is used, as shown in Fig. 46, which is inserted in the handle and the socket bent so that the

Fig. 47—Treating the Eyes.

patient may hold the handle against the body and thus steady it, and at the same time keep the electrode in contact with the eyes, without taking any chances of touching the cord connecting the electrode to the high frequency apparatus. This is shown in Fig. 47. The eyes are closed and the tube kept in light but firm contact with the lids. The current is turned on after the tube is adjusted and is turned off before the electrode is removed, thus saving the patient from any spark. The duration of the application varies from three to ten minutes. If only one eye is affected, only one lobe of the tube may be brought in contact with the eye and the other may extend out to one side of the head, or a special single eye tube may be used. One of the other vacuum tubes may be employed in treating the eye and kept in motion back and forth over the closed lid, or held in contact with it as preferred. This method with a fine spark has proved very effective in blepharitis.

These currents are useful in atrophy of the optic nerve; catarrhal conditions of the eye; absorption of hemorrhages; inflammation of the retina, and in

connection with auto-condensation for the reduction of the blood pressure, they have given remarkable results in glaucoma. Blepharitis, trachoma, iritis, paralysis of the ocular muscles, and cataract, are other conditions in which they have been employed.

Nasal Technique. The diseases of the nose that are specially suitable for treatment are all catarrhal conditions, including ozena (atrophic rhinitis), coryza, etc. Even in hay-fever it has proved useful. The small nasal tube (Fig. 48 or Fig. 21, No. 13) is

Fig. 48—One Form of Nasal Tube.

introduced and the current turned on very slowly. A mild current is all that is required and the length of treatment varies from two or three to seven minutes. It makes very little difference whether the tube is inserted in the straight or the movable socket handle. If the upper or back part of the nasal cavity is to be treated, a tube having an insulated chamber to within possibly three-quarters of an inch or an inch of the end is preferable to the

non-insulated tube. In acute inflammatory conditions the application of a vacuum electrode to the sides of the nose, externally, is advised.

Technique in Treatment of Rectum and Prostate. In treating the rectum for fissure, hemorrhoids, catarrhal conditions, etc., the insulated tube shown in Fig. 21, No. 8, should be used. The non-insulated tube is of much less value for diseases above the sphincter. The rectal tube may be employed in treating the prostate, although the tube specially designed for the latter purpose is the one shown in Fig. 21, No .1, where the depression in the tube is supposed to be turned toward the anterior wall of the rectum, and receive into it a portion of the gland. My new spatulate tube used with one of the flat surfaces toward the prostate gives a larger contact surface, it being doubtful whether with the other tube the gland really ever fits into the depression. In prostatic diseases of all kinds, the high frequency current has proved most efficacious, whether used alone or in connection with some other modality.

In treating both the rectum and the prostate,

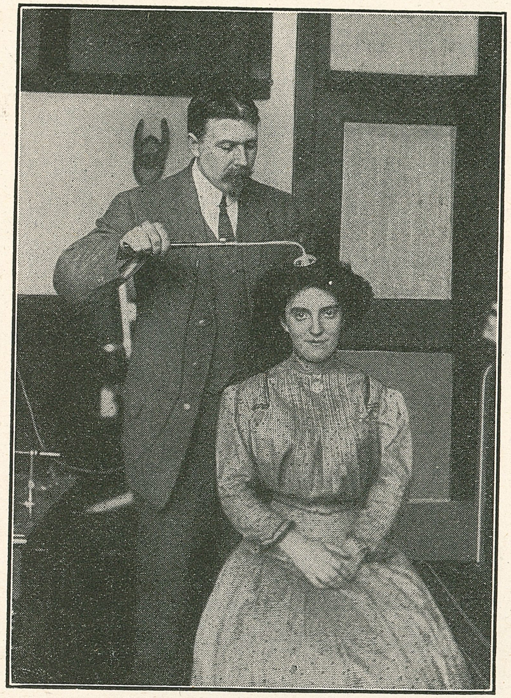


Fig. 49—Treating the Scalp.

my special technique consists in placing the patient on one side in the Sims' position with the knees well drawn up. The electrode is lubricated, inserted in the movable socket handle and introduced into the rectum. The handle is then bent upwards in contact with the body and the patient takes hold of the handle, thus keeping the tube in place during the treatment. The duration of each treatment is seven minutes, and the tube is inserted always before turning on the current and the latter turned off before the tube is removed. Treatment through the rectum is very effective in posterior urethritis, also in diseases of the bladder Occasionally in virgins it will be found desirable to treat uterine or vaginal conditions with the high frequency electrode in the rectum. The current penetrates surrounding structures to a much greater extent than one would suppose.

The special technique for itching is given in Chapter VIII under Pruritis.

Scalp Treatment. In treating the scalp, the body electrode, Fig. 49, is used. The electrode is moved rapidly back and forth over the scalp, using a spark

of from one-quarter to three-quarters of an inch or keeping the tube in light contact with the scalp. If too sharp a spark is used, the scalp will be sore after the treatment and tiny sores will be found. High frequency currents are indicated in all diseases of the scalp, in falling hair, and some years ago I

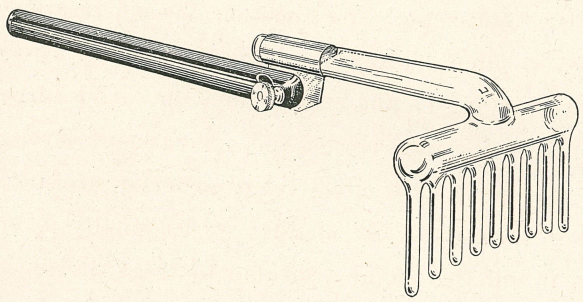


Fig. 49a—The Latest Scalp Electrode.

made the discovery that if employed for a sufficient length of time they are capable of restoring the color to gray hair. This will be specially considered in Chapter VIII. The tube shown in Fig. 21, No. 11, is used conveniently in treating the scalp, being equally as good as the body tube, and a new tube

resembling a hand with glass fingers is the latest. It is illustrated herewith.

Throat Technique. The throat electrode is shown in Fig. 50. Any of the other electrodes may be used externally In acute inflammatory conditions of the throat the low vacuum tube is preferable. The tube may be placed directly in contact with the mucous membrane of the throat or a spark allowed

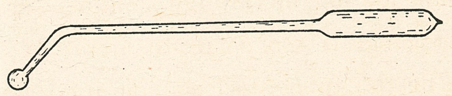


Fig. 50—Throat Electrode.

to pass, according to the nature of the case. Sparks from the regular tube or from the fulguration point have been employed to destroy follicles in pharyngitis or in place of nitrate of silver cauterization, and the fulguration point has even been used in the removal of the tonsils.

Urethral Technique. When employing glass sounds (Fig. 20, No. 5, or Fig. 21, No. 12) within the male urethra, the patient is placed upon his back on the operating table. Whether the knees are

flexed and the legs drawn up depends somewhat upon the individual case; ordinarily the legs are straight, but slightly separated.

The sterilized sound is lubricated and introduced in the same manner that a steel sound would be used, taking care, however, not to use much force, on account of the possibility of breaking the tube. This has happened occasionally, through a prying or sidewise motion, or through a sudden jerk.

If the canal is too small to admit of the easy passage of the tube, steel sounds are used first to dilate the urethra to a sufficient size.

In case a stricture is present and the whole canal cannot be dilated sufficiently to allow the glass tube to pass the stricture, then it is introduced as far as the stricture and the treatment given. On subsequent days it will be found that the stricture gradually disappears until finally the glass tube will pass by it.

When the urethral tube has been properly inserted, the socket of the holder is slipped over it, and the handle bent back over the patient's abdomen.

The patient takes hold of it and thus steadies the

tube. In stricture he is instructed to make steady downward pressure to keep the point of the tube firmly in contact with the stricture. The handle is connected to the machine and the current turned on. In this way the patient experiences no shock. The current is turned off before the sound is removed. Duration of treatment, seven minutes.

Do not forget that the posterior urethra may be treated almost as thoroughly and with much less pain, by introducing a tube into the rectum.

Uterine and Vaginal Technique. High frequency currents are suitable in all catarrhal conditions of uterus and vagina, including leucorrhea, cervicitis, endometritis, etc. They are extremely valuable in specific vaginal diseases in conjunction with the usual method. Treatment through the vagina is also indicated in diseases of the fallopian tubes and of the ovaries and in pelvic abscess and in adhesions. Low or medium vacuum tubes should be used in the latter diseases.

The technique which I use in applying the current in the vagina, is as follows: The patient is placed on her back with her feet in the stirrups

and the lubricated tube in the author's movable socket holder is inserted, and then the handle is bent down to touch the table and the patient's skirts folded over it, thus anchoring the tube and preventing it from slipping out. A towel is then wrapped around the metal connection between the tube and handle to prevent the latter from tipping sideways and thus giving the patient an uncomfortable spark. The cord connecting with the generating apparatus passes out under one leg of the patient and care should be exercised to see that it does not come in contact with it, nor should it rest upon any metal which touches the patient, for if there be a defect in the insulation a sharp current will be communicated along the metal. After the tube is properly adjusted the current it turned on and allowed to pass for seven minutes, when it is turned off before removing the tube. In very acute cases, I have not hesitated to give two or three treatments in a day until improvement took place. Ordinarily from one treatment a day down to two or three treatments a week will prove satisfactory in subacute or chronic cases. The insulated vaginal tube

should be used. It is shown in Fig. 21, No. 10. The prostatic tube also makes an excellent one for vaginal use, and Fig. 27 shows my new spatulate tubes, which admit of contact with a larger surface. Occasionally in treating diseases of the cervix, a small electrode may be inserted within the canal, taking care to insulate against contact with the metal speculum, if the latter is used. (An old-fashioned glass one is better.) In cancer, the fulguration tube may be used through the vagina to destroy the cancerous tissue. This may or may not require an anaesthetic.

One authority packs the vagina with moistened gauze with a metal electrode in the center and thus carries the current to all contiguous parts. The D'Arsonval current may be used in the vagina by this method. Direct D'Arsonvalization is now known as diathermy. See Chapter XI.

CHAPTER EIGHT.

Practical High Frequency Therapy, Diseases Alphabetically Arranged with the Technique to Be Employed.

Explanatory. In the following pages no special attempt has been made to distinguish between diseases in which the high frequency current is the sole treatment required and those in which it is of temporary value or useful merely as an adjunct to other methods; therefore, including a disease in the list, does not imply that the author necessarily considers high frequency the only, or even the best, treatment for it. Where he has a pronounced opinion, however, he has not hesitated to express it.

To avoid frequent repetition, where auto-condensation is referred to, it is given according to the technique in Chapter VI; the same with fulguration, etc. Where special regional technique is advised,

as for the prostate, vagina, etc., the directions in Chapter VII are to be followed unless otherwise indicated.

Where small Tesla coils are used with the vacuum electrode, it should be remembered that the current is sharper than that from the Oudin or larger Tesla, and shorter sparks must be used than the average stated, or the patient will complain.

Where two spark-lengths are given, for example, one-quarter to one-half inch, the shorter would be for the machine giving a "hot" spark and the longer for one giving a comparatively "cold" spark.

Bear in mind that this stating the strength of a vacuum electrode in terms of a certain length of spark does not necessarily mean that the tube is held away from the surface so that a spark of that length actually passes, but means that enough current is passed through the electrode to make such a spark possible. Usually the tube is kept in contact with the skin and where it is not it is so stated in the text.

In any of the cases calling for the spark the indirect spark may be used instead of the direct. See Chapter VI.

Where general treatment with the vacuum electrode is given to take the place of auto-condensation or auto-conduction, the treatment must be much longer than that for a purely local effect. The average duration of local vacuum tube treatments is from five to ten minutes; for auto-condensation or auto-conduction, ten to thirty minutes, and for the general tube treatment referred to, from twenty to thirty minutes.

A number of symptoms or conditions have been indexed for convenience as if separate diseases, such as paralysis, constipation, pruritis, etc.

Insulated tubes are preferable in treating the various orifices of the body. In general, limit orificial treatments to seven minutes to avoid possible burns.

In stating dose of auto-condensation I have employed my **new unit** of measurement, **the Eberhart,** a full discussion of which will be found under that heading in Chapter VI. It is based on 100 milliam-

peres meter reading per minute to each 1,000 volts of potential

There are two types of apparatus employed, which I will designate as Number One and Number Two. I wish to remain absolutely neutral on the question of whether one type or the other is superior for auto-condensation.

Type No.1. High voltage, low amperage. I assume that the voltage is about 50,000. This is not official, however. The machine operates ordinarily at an average meter reading of 350 to 500. In using it I never try to crowd it above 500, and usually employ it at about 400. Where a larger dose is necessary I prefer to lengthen the time, rather than increase the amperage. On the voltage stated the number of Eberharts per 100 milliamperes is 50.

Type No. 2. Low voltage, high amperage. I assume, unofficially, the voltage to be about 25,000, average meter reading 700 to 1,000. I believe the majority of operators use it at about 1,000, and here again I prefer lengthening the time in giving a

larger dose, rather than to crowd the meter reading to a higher point. Based on 25,000 volts, the apparatus delivers 25 Eberharts to each 100 of meter reading, and although the voltage is one-half that of No. 1, it is operated at twice the average meter reading, which leaves the time of treatment the same.

The following table shows how the time coincides, the average being about ten to fifteen minutes on either to give 2,500 E.

No. Eberharts per 100		Meter Reading		No. Eberharts	Minutes for 2,500 E
No. 1	No. 2	No. 1	No. 2	Both types	Both types
50	25	200	400	100	25
50	25	250	500	125	20
50	25	300	600	150	16.67
50	25	350	700	175	14.28
50	25	400	800	200	12.50
50	25	450	900	225	11.11
50	25	500	1,000	250	10

The manufacturer should state in his instructions for auto-condensation how many Eberharts per 100 of meter reading his machine produces, when the time in minutes is easily calculated.

The average dose of auto-condensation is 2,500

Eberharts, but where satisfactory results are not shown after six to ten treatments it is my custom to increase the dose to 3,750, 5,000 or even 7,500 Eberharts, doing so by lengthening the time. I first lengthen the time to about one-half more, and if results after another ten treatments are not as expected, I increase to double the original time, and so on. In the following pages where the dosage is given as 2,500 to 7,500 E., this method is intended to be followed. There is, generally speaking, no overdose of auto-condensation, therefore, considerable latitude in dosage is allowed, only be sure and dose enough. The only contra-indications I consider are high temperature in the patient or a pulse pressure of 20 or less. In the first instance I would start with about 1,000 to 1,250 E. and wait until the third day before repeating, generally increasing dose and frequency as patient showed toleration, as indicated by a correspondingly smaller rise in temperature immediately following treatment.

In the latter case if patient was applying for first treatment. I would not employ auto-condensation at all, but spinal sparks instead If patient had been

under treatment for high blood pressure and pulse pressure went to 20 or below, I would either stop the treatment for a few days or give the small dose (1,000 to 1,250 E.), and if it still stayed as low, I would abandon auto-condensation, even though the systolic blood pressure was still abnormally high.

When the blood pressure of the patient is normal or below normal, auto-condensation generally would be contra-indicated, but in those cases where it is desired to use it for its effect in improving metabolism, the dose should average about 1,250 Eberharts and should be given at a low meter reading (200 to 250 for No. 1; 400 to 500 for No. 2). If this is shown to materially decrease the systolic blood pressure, each treatment should be followed by sharp sparks to the patient's spine, for five minutes.

Abscess. To prevent the formation of an abscess, the use of a low vacuum electrode is theoretically indicated. The intensity of current employed should be that capable of producing a spark of one-quarter to three-quarters of an inch, but in employing the tube it should be kept in contact with the skin. Use enough current to get the effect of the heat gener-

ated. Duration of treatment ten to fifteen minutes, repeated daily or twice a day if necessary. In those cases where an abscess already exists the high vacuum tube is preferable, using the same intensity. Duration of treatment, seven to ten minutes. High candle power ligths are useful in connection with high frequency.

Acne Rosacea (Red Nose). To destroy the enlarged veins in this disease, the spark must be employed to get a cauterizing action. For this the best method is to use the fulguration edectrode, regulating the strength of spark in accordance with the toleration of the patient and treating from two or three up to six or eight minutes at a sitting, according to the amount of destruction required. A spark from one-quarter to one-half of an inch in length from any vacuum tube may be employed in place of a fulguration point With the latter, the treatments should not be repeated until the effect of the first has subsided, which will average from six to ten days. The X-ray in connection with the high frequency current is indicated, but I believe carbon dioxide snow, first suggested for this purpose by

me, is superior to either, and we must not forget the curative effect of electrolysis.

Acne Vulgaris (Pimples). One of the best fields for the employment of high frequency is in this form of acne. It is used preferably in conjunction with the X-ray, and with this combination a cure should be effected in practically every case. The vacuum tube is used for the high frequency application,—the so-called body tube, Fig. 51, being that ordinarily employed, and a sufficient amount of current passed through the apparatus to produce a spark of one-quarter to three-quarters of an inch. The tube, however, is not raised from the skin, but kept in light contact with it, dusting on talcum powder if the tube sticks to the skin, or else treating through a single thickness of cloth, as through a handkerchief. In place of the body tube, I have found that any of the glass vacuum tubes ending in a vacuum not less than an inch in diameter may be employed as easily as the body tube. For instance, the prostatic tube, Fig. 21, No. 11, makes an excellent electrode for treatment of the face, because the edges surrounding the depression on the surface of the

Fig. 51—Body Electrode Applied to the Face.

tube enable the operator to get a better contact about the nose or other sharp angles than is possible with the body tube. The tube is kept moving rapidly back and forth over the surface and is not allowed to remain stationary over any point. Lately I have made considerable use of the indirect spark with the patient on the auto-condensation pad. If the treatment is given in connection with the X-ray, the duration of the high frequency treatment should be from three to five minutes, but if given alone, a treatment of seven to twelve minutes is indicated. Treatments may be given three to six times a week with the high frequency, but not more than three seven-minute treatments per week with the X-ray. The high frequency X-ray tube proves very satisfactory for the treatment of acne, as little penetration is required. Where pustules are forming, I have found it advantageous to raise the tube for fifteen to thirty seconds and apply for that length of time a reasonably sharp spark. This often aborts the pustules, and even if it does not, will limit their size. I do not approve of deep lancing of pustules on account of the consequent scarring When a

yellow head appears on the pustule it should be opened with a sterilized needle, and then instead of using pressure to evacuate the contents, the shaft of the needle should be passed across the pustule, which will remove all of the pus that is ready, without bruising the tissues and extending the focus of infection.

Where scars are already present there is no more efficient application for them than a sharp spark from the glass electrode, or a very mild spark from the fulguration point may be employed.

Actinomycosis (Ray Fungus). In this disease the high frequency spark is employed as an adjunct to the X-ray. The spark should be from one-quarter to three-quarters of an inch in length, according to the toleration of the patient, providing the vacuum tube is used. If the fulguration point is employed, a shorter spark is required. Three treatments per week.

Adenitis, Cervical (See Tuberculosis of Glands).

Adhesions. Where pelvic or other adhesions follow operations or inflammatory conditions, the high

frequency current will be useful. The vacuum tube is employed, using an intensity capable of producing a one-half inch spark and keeping the tube in light contact with the abdominal wall, passing back and forth over the area involved for from seven to ten minutes. In pelvic adhesions, the use of the vacuum electrode in the vagina in connection with the surface application will hasten results. Mechanical vibration is advised in connection.

Albuminuria (Nephritis; Bright's Disease) Benefit in these diseases has been obtained from the application of high frequency currents. The best method is the use of auto-condensation, 2,500 to 7,500 E. per day, in connection with the use of a vacuum tube over the region of the kidneys There have been many reports of the disappearance of the albumen following this method of treatment. I have myself seen both albumen and casts disappear, but do not wish to be understood as making the statement that this treatment will cure Bright's Disease. That it is of sufficient value to warrant its employment, if possible, in every case, is my firm belief, particularly in cases where high blood pressure ex-

ists. This is always the case in chronic interstitial nephritis, as high pressure in the renal artery is apparently the primary cause of the disease. (See Arteriosclerosis.) Auto-condensation in these cases will lower the blood pressure and by relieving the pressure in the kidney, the strain is taken off the filtering tubules and the result is at least beneficial even if not necessarily curative. High frequency in this disease must be considered solely as an adjunct to our usual routine treatment and should not be looked upon as taking the place of these measures.

Alcoholism. Use of the vacuum tube over the spine, solar plexus and to the extremities in connection with other means to overcome the effects of alcoholism, has been advised by several operators. If the blood pressure is high, the spinal application would be contra-indicated and auto-condensation or auto-conduction should be substituted. The latter forms are also specially sedative where nervous excitement is present. (See Drug Addictions.)

Alopecia (Loss of Hair). Where baldness occurs as a result of faulty nutrition, the high frequency

current naturally suggests itself as an ideal remedy. The applications are made with the vacuum tube, using either the tube shown in Fig. 51 or that in Fig. 21, No. 11. Sufficient current is to be sent through the apparatus to make it possible to draw a spark of from one-quarter to three-quarters of an inch. A case being treated with the spark from a portable outfit is shown in Fig. 52. The tube is ordinarily in light contact with the scalp, but occasionally may be raised slightly, giving a short but rather intense spark. It is to be kept moving about over the scalp, for from five to ten minutes at a treatment. If too sharp a spark is employed, the scalp will become sore and tiny little places will appear where it has exerted an escharotic effect. To get the best results a daily treatment is advised, and two short treatments per day would not be too much. In connection with the high frequency a few moments' use of the vibrator is strongly advised. In Alopecia Areata, the X-ray is employed in connection with the high frequency current, using a medium or high vacuum. The scalp is particularly sensitive to the X-ray.

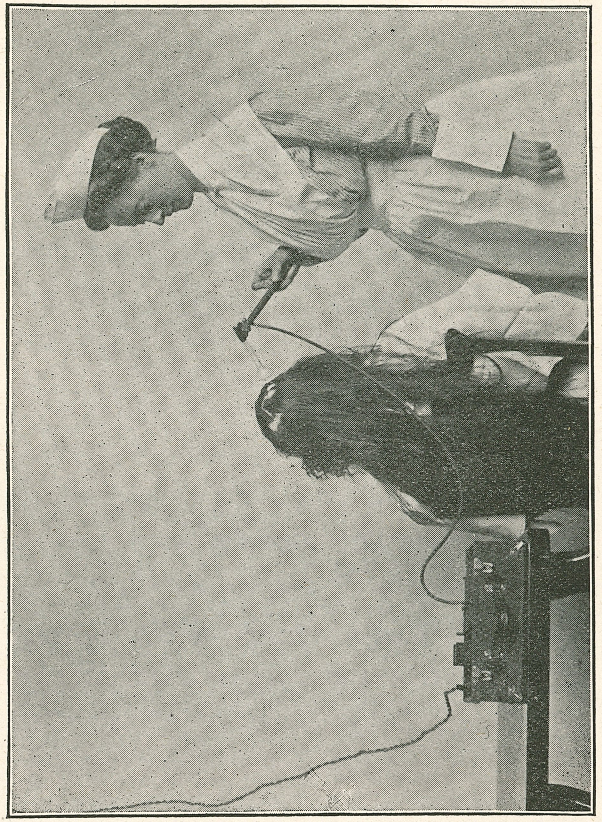


Fig. 52—Treating Alopecia (Lloyd).

Amenorrhea. That the high frequency current when applied through the vagina sometimes has an emmmenagogue effect has been noted by several authors. I have occasionally observed the same effect, although I cannot reconcile this action with the beneficial results we obtain from the same current in menorrhagia and metrorrhagia; conditions which are precisely opposite. As the current determines an increased amount of blood to the area treated, its employment in absence of the menses would appear reasonable. The technique is the use of the insulated vaginal tube for seven minutes, three to six times a week, and in connection therewith, the application of a spark to the lower part of the spine for from three to six minutes. Another method is to use the bi-polar Tesla treatment with one pole over the sacrum and the other over the tubes; two or three times a week.

In those cases that result from anemia, the general effect on metabolism of auto-condensation will call for its employment, 2,500 to 7,500 E. three to six times per week. Mechanical vibration is very effective in amenorrhea, and should be employed in

connection. In virgins, where the menstrual function is irregular, a small tube, such as shown in Fig. 20, No. 4, may be employed, or the treatment given through the rectum with the insulated tube shown in Fig. 21, No.8. Ozone inhalations will still further assist in those cases caused by anemia.

Anemia and Chlorosis. As high frequency currents increase the oxygenation of the blood, thereby increasing both the reduction of oxyhemoglobin and also the number of red corpuscles and the percentage of hemoglobin, their employment in anemia, especially of the chlorotic type, is quite as effective as iron tonics, and at the same time does not interfere with the joint use of the latter. The method of administering the current is by auto-condensation. If the blood pressure is normal or above, give 2,500 to 7,500 E. three to six times per week. If the blood pressure is below normal give 1,000 to 1,250 E. with meter reading about 250 for low amperage machines, and 500 for high amperage outfits.

Ozone inhalations are clearly indicated and are of the utmost value in these cases. In one of my

cases the percentage of hemoglobin increased from thirty per cent to eighty per cent in eight weeks. Intra-muscular injections of iron solutions are advised.

Aneurism. Auto-condensation, 2,500 to 5,000 E., three to six times per week gives relief, but is, of course, not curative. Under no circumstances should the vacuum electrode be employed locally over the aneurism.

Appendicitis, Catarrhal. In catarrhal appendicitis, the vacuum tube has been employed locally, using a tube capable of emitting a one-fourth or one-half inch spark, keeping it moving in contact with the skin over the region of the appendix. Both the monopolar application from the resonator or Tesla, and the bi-polar Tesla current have been employed. In the latter case, the other pole is placed over the lumbar region, or grounded by attachment to gas or water pipe. It is my opinion that appendicitis, in any form, is a disease which high frequency operators should not trifle with, but turn over to their surgical friends.

Arteriosclerosis and High Blood Pressure. Arteriosclerosis is a disease that is of the utmost importance, because it is the primary condition which results in so many diseases of kidneys, liver, heart and brain, which we are accustomed to classify according to the organ more particularly affected. Arteriosclerosis, formerly looked upon as the heritage of old age, is now very common and greatly on the increase because of our present mode of life with its strenuous efforts to gratify ambition; its excesses and indiscretions in eating, drinking, etc. Today there are many men young in years whose arteries are those of the octogenarian and forecast the probability of a sudden termination of their usefulness.

The most prominent and persistent symptom of arteriosclerosis is high blood pressure. The circulatory system may be compared to an electrical plant, in which the heart is the central station or dynamo and must necessarily have a pressure sufficient to overcome the resistance in the circuit. Therefore, we have the pressure decreasing in the arteries, less in the capillaries, and still decreasing as the veins grow larger. Thus we have the com-

plete round of the circulation, the blood following the rule of water and of electricity and flowing from a higher to a lower pressure. Normal pressure of the blood in the arteries is sufficient to support a perpendicular column of mercury of from 110 to 120 millimeters In arteriosclerosis it sometimes increases to over 300.

The disease is usually divided into the functional and organic stages. The first would be the stage previous to the real hardening of the arteries and the latter that in which structural changes actually had occurred.

In the functional stage there comes to be present a contracted condition of the artery, producing thereby increased tension and raising the blood pressure. At this time this is the result of irritation and spasm on the part of the muscular fibres and no actual degeneration or permanent change in structure has appeared. Thus the disease develops gradually and without any particularly noticeable or alarming early symptoms. The theory is that toxins in the blood first cause irritation, then contraction or spasm of the arteries, which may be intermittent, but be-

come a more or less steady contraction, increasing the pressure by narrowing the caliber of the artery and finally attaining the permanent changes of the second stage. The causes producing the original irritation are gout, uric acid, lead poisoning, syphilis, diabetes, excesses or abuses in eating, drinking, tobacco, etc. There is faulty conversion of food products into living cells with failure to properly eliminate poisons from the system and the absorption of the products of imperfect intestinal digestion (autointoxication).

Of the errors in diet, the most common is the consumption of too much nitrogenous food, especially red meats and substances rich in proteids. Other causes of arteriosclerosis are worry; prolonged mental or muscular strain, and the after effects of infectious diseases. Although more common after the age of forty, no period of life is exempt; cases occurring at the ages of eight, fifteen and twenty-eight years being on record. Whatever the treatment undertaken for the disease, there must necessarily be a regulation of habits to overcome the causes stated above The diet should be simple, all

alcoholic beverages tabooed; tobacco should be prohibited or used sparingly. Milk or buttermilk are allowed, especially the buttermilk made with lactic acid ferments. Red meats are to be eaten sparingly, but plenty of vegetables are advised.

There has been a tendency on the part of many physicians toward the partial or complete elimination of salt from the diet. The individual should take his time, and avoid all worry, haste and excitement. In addition, strict attention should be given to personal hygiene and regular but moderate exercise, baths, etc. It has been shown experimentally that in a normal subject, the blood pressure may be raised from five to ten millimeters by taking a cup of beef broth. Therefore, the necessity for curtailing the amount of red meat is apparent.

One of our Chicago millionaires consulted two celebrated German specialists, Dr. Grodel of Nauheim and Dr. Vogel of Ems. The directions given by each were almost identical, and I herewith give the combined list:

"Two cigars daily, separately. Coffee, three-fourths milk, or dekafa. Chocolate. No tea. No

Turkish baths. Swimming all right. Horse-back riding; slow horse. Slow golf. Automobiling all right. No stairs; no strain; no hurry. Eat coarse graham bread like Nauheim. **Never over-eat, it kills!** No sweets. No cabbage, fresh bread or foods causing flatulence. Champagne and wines do the same (cause flatulence). Eat lightly and more often if necessary."

Although high blood pressure is the rul,e if the heart is dilated and there is a tendency to dropsy and congestion, there may be a low blood pressure. In these cases it is necessary to be sure of the pulse pressure. (See Chapter VI under "Taking Blood Pressure.") The most important and constant symptom, however, is high blood pressure. In Figs. 44 and 44a the process of taking the blood pressure is illustrated (For the technique of taking the blood pressure, see Chapter VI.)

The electrical treatment of arteriosclerosis is the use of the high frequency current by auto-conduction or by auto-condensation. The preliminary dose is 2,500 E., and it should be given daily in the beginning, and less than three treatments a week at the start are useless.

As the blood pressure approaches normal, the treatments may be reduced to three a week, then to twice a week, and if there is no tendency to a rise in pressure, then once a week. A treatment every week or two should be maintained for some time in order to be sure of the permanency of results. It is not enough to force the pressure down and then suddenly abandon all treatment. It will require on an average about 40 to 50 treatments to bring the pressure from 200 down to 140 or under, or to the point where only one treatment a week is needed.

The pressure is taken before giving the treatment and if taken after shows an average reduction of about 10 to 12 millimeters. In a few hours the pressure is back nearly to where it was before, the net reduction being from one-half to two millimeters, according to the individual and the degree of pressure. When the pressure is over 200 I expect to get a net reduction of two millimeters for each treat-

ment. Between 200 and 160 I look for an average of one and one-half points, while below 160 it will be from one down to one-half millimeter. In some cases it goes down steadily for 10 or 15 points, and then remains stationary for a week or two, and then down another series.

Dr. John Ritter of Chicago has shown that the blood pressure, like the pulse, varies with the position of the patient, whether standing, sitting or lying down. Therefore, it should be taken on subsequent occasions with the patient in the same position.

It should not be taken too often, say, once a week, as otherwise the gain is not specially noticeable

Occasionally, just as the pulse had been cut off by the pressure on the brachial artery and I had noted the systolic reading, the pressure would go up five, ten or twenty millimeters. This I have attributed to a spasm taking place in the brachial artery from too frequent taking of the pressure.

At the end of ten treatments, if the blood pressure is not reducing in accordance with the rate given above I increase the length of the treatments,

about one-half (3,750 E.), but do not increase the meter readings. After another ten treatments, if the reduction is insufficient, I lengthen the time to twice the original (making 5,000 E.), and so I keep crowding the dose until I get results or convince myself that it is impossible. Many operators fail because afraid to push the dose.

When taking the pressure, take both systolic and diastolic, and note their difference, pulse pressure.

In these cases we are only interested, as a rule, in low pulse pressure, and this should never remain long under 20. If it does we have carried auto-condensation as far as it will do any good, and it must be stopped, as further treatment will entirely disturb compensation and endanger the patient.

Ordinarily the systolic and diastolic pressures go down simultaneously, though not always the same number of millimeters. Occasionally the systolic goes down faster than the diastolic until the pulse pressure reaches 20. I then lessen the dose to 1,000 or 1,250 E., or skip a treatment or two, and if after this it remains at 20, or possibly goes down to 18, I stop the treatment altogether, whether the systolic

is down to normal or not, and usually give some sharp sparks to spine to raise the systolic, and thereby also the pulse pressure, until the latter is above 20.

I have met with occasional cases in which no benefit or only a very temporary reduction followed the use of auto-condensation.

Increased determination of blood to the surface of the body lowers the blood pressure and, conversely, driving the blood from the surface, raises it. Therefore, any remedy that increases peripheral circulation lowers the blood pressure. In addition to the drugs employed for this purpose may be mentioned electric light baths, oxygen baths, etc. In advanced cases care should be exercised not to reduce the blood pressure too rapidly at first.

We must not lose sight of the fact that either auto-condensation or auto-conduction, if capable of lowering blood pressure, is equally capable of preventing the development of arteriosclerosis when employed at the first sign of increased pressure. In brief, the effects of old age may be discounted.

I voice the view of many authorities when I state

that a man past forty, who is under considerable strain or carrying a heavy load in his business or profession, and who finds difficulty at times in concentrating his attention, awakens in the morning more tired than when he went to bed; has occasional spells of dizziness or light-headedness, or notices occasional tingling or numbness in the extremities, owes it to himself to ascertain whether or not these symptoms are pointing toward the development of arteriosclerosis. If his fears prove groundless, well and good; but if evidences of arterial involvement are present, they will be discovered in time to prevent their untoward effects.

Articular Rheumatism (See Rheumatism).

Asthenopia. Use the body electrode carrying a spark of from one-fourth to three-fourths of an inch, according to the sensitiveness of the patient, and keep the tube at full sparking distance. Pass it rapidly up and down the spine for three minutes.

This treatment is satisfactorily applied through some layers of clothing, as the latter insure a definite spark length. In women the corset should be removed if any steels are where they will be charged

by the current. If a chain is worn around the neck it should be taken off.

Follow the spinal treatment by an application of the same tube to the back of the head and neck for three minutes longer, then over the eyes for two or three minutes, keeping it in contact with the skin. Finally use the double eye tube, Fig. 6, for three minutes. Three to six treatments per week.

Ozone inhalations and vibration are useful adjuncts.

Asthma. The treatment of asthma may be by vacuum tube applications over the chest or by placing a diaphragm so that a powerful effleuve or fine sparks will fall upon the chest.

The vacuum tube should be used with as sharp a spark as the patient will permit and is conveniently applied through the underclothing.

Mechanical vibration is especially useful in connection with high frequency.

Direct D'Arsonval application with one sponge to the back and the other moved back and forth over the chest is another method. Daily treatments of

about ten minutes' duration. A cure should not be expected.

Ataxia (See Locomotor Ataxia).

Atonic Dilatation of the Stomach. In this disease we have complete relaxation of the motor fibres of the stomach and the treatment must be that which will cause them to actually contract and regain their normal tone. The first cases treated by high frequency were those reported by Chisholm Williams. He employed the vacuum tube for five minutes locally over the stomach, followed by auto-condensation for ten minutes This treatment was repeated daily. In one case a cure resulted in six weeks. This author also reported results in seventeen cases treated by Drs. Crobie and Bokenham. The results were proved by skiagraphs.

One method that has been used in treating this disease has been to localize the effects of auto-condensation by using the metal electrode and placing a piece of plate glass between the electrode and the stomach area. The plate glass is the di-electric. The electrode corresponds to one layer of condenser, and

the gastric area to the other, thus obtaining the effect of auto-condensation.

I have found general auto-condensation treatments (2,500 to 7,500 E.) were entirely satisfactory for this disease often combining with a mechanical vibration. The sinusoidal current has proved of essentially equal value. While applying the general auto-condensation on the couch, it is possible to draw sparks from the body with the vacuum tube locally over the stomach at the same time with benefit. The foregoing treatment is equally effective in atony of the stomach when dilatation is not present.

Atrophic Rhinitis (See Ozena).

Atrophy of the Optic Nerve. The method of treating this disease with high frequency currents has been by the use of the eye electrode, single or double, as required, the same being held in contact with the closed eyelid and the current allowed to pass for from five to ten minutes. The current is of a strength just short of producing painful sparks on the lid. In place of the eye electrode, I have used the form shown in Fig. 21, No. 11, using a current

that would not be capable of producing a spark of more than one-sixteenth of an inch, and keeping it in light contact with the lid while it is passed back and forth for several minutes. Another author suggests at the same time an application with a stronger current, keeping the tube in loose contact with the skin over the temple for about the same length of time. Daily treatments are advised.

Baldness (See Alopecia).

Barber's Itch (See Sycosis).

Bladder Disease (See Cystitis).

Bladder, Papilloma of. See technique under Fulguration, Chapter VI.

Blepharitis. In a large number of cases of blepharitis a cure has resulted from the use of a very mild spark from the vacuum tube. Sometimes it has to be persisted in over a long period on account of a marked tendency to relapse. One case referred to me by Dr. Rager which had resisted all of the usual routine treatment improved rapidly under three applications a week of the high frequency current in connection with the high candle power light. Over sixty treatments were given, however, before the

case was essentially cured. Fox treated 100 cases with no failures.

The technique which I employ is as follows: I use the electrode shown in Fig 21, No. 11, with just enough current to produce a stinging sensation when applied to my own eyelid, the fine spark from it being from one-thirty-second to one-sixteenth of an inch length. I raise the upper lid by pressure with the thumb and apply this fine spark along the edge for two minutes, and then pull the lower lid down and do the same. Then while the patient closes the eye I pass the electrode over the whole surface of the lids for two or three minutes longer. A daily treatment is preferable, but three times a week will suffice.

Blindness from Intra-Ocular Hemorrhage. In this condition the current is used to promote absorption, and as the blood pressure is always high, there is an indication for the use of auto-condensation or auto-conduction for the purpose of reducing it.

I report a most interesting case which occurred in the wife of a Methodist clergyman. She became suddenly blind in the left eye and applied to me for treatment. Not being an oculist I referred her to Dr. Good for diagnosis, and he found on examination that a considerable hemorrhage had occurred thus obstructing the vision. An unfavorable prognosis was given. I treated the case in the following manner: The patient's blood pressure was 156 and there were abundant signs of arteriosclerosis, so she was given first 2,500 Eberharts on the auto-condensation couch, after which the vacuum electrode (Fig. 21, No. 11) was rubbed gently over the closed eyelids, temple and supra-orbital region, using a mild current, capable of giving a slight stinging sensation when passing in loose contact with the skin. After this, very mild mechanical vibration was applied through my fingertips to the closed eye for thirty to sixty seconds only. Daily treatments were given and the result was little short of marvelous. Inside of two weeks the sight returned to the eye and a few weeks later it was stronger than before the hemorrhage occurred, as the patient had had some difficulty with this eye for many years.

Blood Pressure. See Hypertension (High Blood Pressure), also Hypotension (Low Blood Pressure), and Arteriosclerosis.

Boils (See Furunculosis).

Brachial Neuritis (See Neuritis).

Brain Fag. "Brain Fag" has come to represent a condition just one step removed from complete nervous prostration. It is common in business men, especially where too close attention to business has been accompanied by too little exercise. The favorite prescription has been a complete change of scene, such as a sea voyage. This treatment is not always possible, and much may be accomplished by the use of high frequency currents, ozone, and mechanical vibration.

The nature of the high frequency treatments should be in accordance with the patient's blood pressure. If the blood pressure is high, auto-condensation or auto-conduction is clearly indicated, and 2,500 to 5,000 E. should be applied daily, or even twice a day if the case is urgent. Following this, the vacuum tube with a spark just strong enough to have a good tonic effect should be applied to the forehead over the eyes and to the back of the head and neck. The patient will nearly always complain of pain in the back of the neck, the pain so common in neurasthenia.

In many of these cases the blood pressure is below normal and in these the use of auto-condensation or auto-conduction is distincly contra-indicated. Instead there should be the application of sharp

sparks, say one-half inch or more in length, up and down the spine for four or five minutes, then over the abdominal region for three minutes more, finishing with the application over the eyes and back of the neck, as outlined above.

In all cases, two or three minutes' inhalation of ozone after the high frequency treatment is desirable or if possible the patient should install an ozone machine in his office and also in his sleeping room so that he is constantly breathing air charged with a large amount of ozone. (See Chapter IX.) When the blood pressure is low a mild stimulating application of mechanical vibration along the whole spine is indicated, dwelling somewhat longer over the back of the neck.

Bronchial Asthma. (See Asthma.)

Bronchitis. High frequency currents are useful in acute bronchitis but circumstances usually render them unavailable. If, however, the physician has a portable high frequency outfit and there is electricity in the patient's room, he will find that a reasonably sharp spark over the chest and back, until they are well reddened, will give relief, this treatment may be repeated every hour until a sufficient moderation of congestion is obtained.

An ozone generator should be placed in the room

to ozonize the air. This is really more important than the high frequency application.

In chronic bronchitis the vacuum tube may be used over the chest and back, as in the acute form or a shower of fine sparks or the effleuve from the diaphragm may be employed, first over the chest and then over the back or else the patient placed between the diaphragm of a double resonator.

At the present time in connection with the vacuum tube application general auto-condensation is employed (2,500 E.) or it may be applied locally according to the "Plate-glass method" described in Chapter VI. Here ozone is again clearly indicated, the preferable method being ozonization of the air in the room where the patient sleeps or works; this being superior to the temporary administration of ozone in the physician's office. Treatments should be given daily at first, gradually dropping to two or three times a week.

Callouses Callosities of all kinls, including corns, are treated by the application of sharp high frequency sparks; either from glass or metal electrodes or by means of the regular fulguration point. Caustic fulguration is preferable.

Cancer. (See Carcinoma.)

Canities. (See Gray Hair.)

Carbuncle. In treating carbuncles the high frequency currents are used as an adjunct to the X-ray, although they have proved effective when used alone. Enough current should be sent through the tube to produce a one-fourth to three fourths inch spark and the tube should be kept in loose contact with the inflamed area and passed back and forth over it for ten or fifteen minutes. This should make

Fig. 53—Cancer Treated by Fulguration. Three Weeks' Time Between Successive Pictures.

an appreciable difference in the pain and promote an early ripening of the carbuncle.

In cases where suppuration has already occurred the progress of the case may be hastened by the same technique.

Carcinoma (Cancer). The best treatment for can-

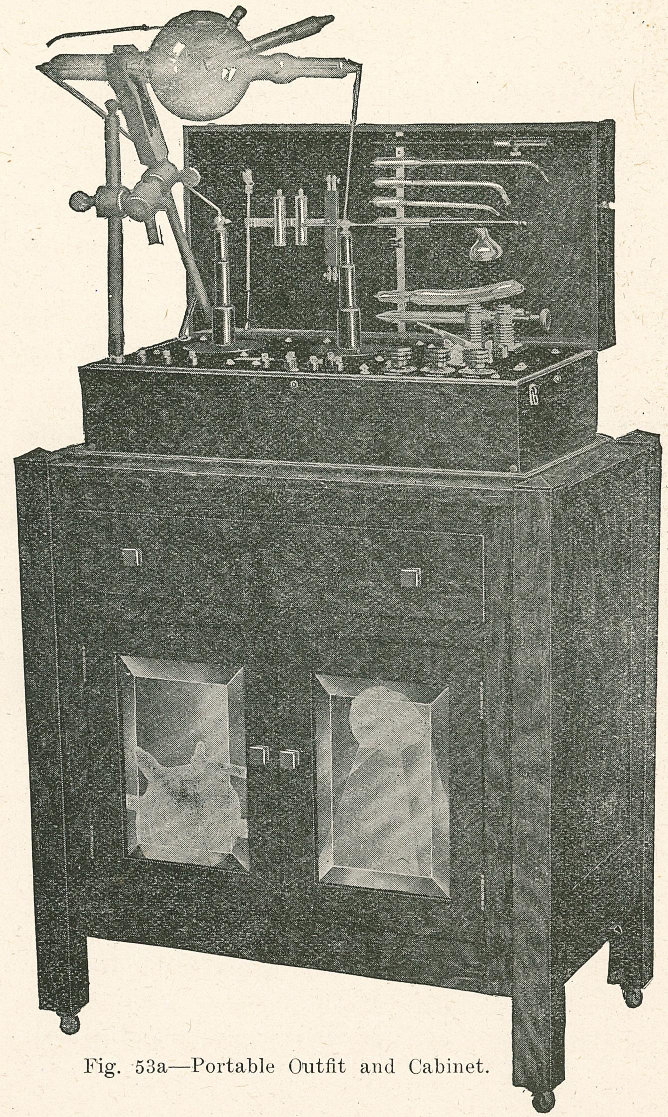


Fig. 53a—Portable Outfit and Cabinet.

cer is the use of the X-ray in connection with surgery, but in many instances benefit is obtained from the local use of high frequency sparks. The present method of utilizing these sparks is by means of caustic fulguration. (See Chapter VI.) Anaesthesia may be necessary.

In Fig. 53 is shown a case of cancer treated by Dr. Carreras by fulguration, a small portable coil being employed. The middle picture was taken three weeks after commencing treatment and the right hand picture in another three weeks.

Cataract. In the early stages of cataract benefit may be expected from the high frequency current in a reasonable percentage of cases.

It is applied according to the eye technique given in Chapter VII. Five minute daily treatments with not too great an intensity of current; tube in contact with closed lids.

Catarrh of Bladder. (See Cystitis.)

Catarrh of Bowels. (See Colitis and Enteritis.)

Catarrh of Nose. (See Nasal Catarrh; also Ozena.)

Catarrh of Womb. (See Endometritis; also Cervicitis.)

Cellulitis. The red vacuum is preferable in treating cellulitis. After freely incising the parts to establish drainage, apply wet dressings and then use

the high frequency current through the dressings, five to seven minutes, repeating frequently.

Occasionally in an early stage the application of the high frequency in connection with a high candle power light may arrest the progress of the trouble; but if it does not do so quickly, the above method is advised.

In this instance the current is merely an adjunct to our usual methods.

Cerebral Hemorrhage. Dr. L. M. Bowes, who has had a wide experience in these cases, states:

The prophylaxis consists in treating the underlying cause—arteriosclerosis, nephritis, chronic alcoholism or syphilis—which is described under the proper heading.

When there are prodromal indications of hemorrhage—headaches or dizziness, in one whose arteries are liable to rupture—the patient should be placed in bed with the head raised and feet lowered. If there is hypertension, auto-condensation or auto-conduction is indicated.

Give a brisk purgative followed by an enema. During the attack the patient should be kept absolutely in the position given above, with an ice-cap on the head and heat applied to the extremities. Hot baths should be absolutely forbidden.

The absorption of the extravasated blood is pro-

moted by the use of auto-condensation or auto-conduction, combined with the use of small doses of the iodides.

For the paralysis the treatment should be the same as outlined under the heading of paralysis, remembering that only the weak muscles should be treated. If the strong muscles are treated the contractions are liable to be increased.

Cervical Adenitis. (See Tuberculosis of Glands).

Cervicitis. In inflammation of the neck of the womb, with or without hyperplasia, the use of the high frequency current through the vagina is very effective.

The insulated vaginal tube is employed and care is taken to be sure that it is in contact with the cervix. Seven minute treatments, daily or every other day, using a current strength that would be capable of producing a one-half or three fourths inch spark if the tube were not in contact with the body.

A small tube, such as the nasal tube, may be inserted in the neck of the womb in cases accompanied by relaxation, where the mouth of the uterus is open. This tube must not come in contact with a metal speculum or it will charge it with the current. It must be insulated with rubber or sufficient dry gauze. A glass speculum of the old-fashioned tubular type is preferable. The direct D'Arsonval cur-

rent (diathermy), is also useful in this disease. (See Chapter XI.)

Where the cervix is considerably enlarged mechanical vibration is advised. I have devised a uterine vibratode which is very convenient and serviceable in treating these cases, because the vibrations may be limited to the desired area. It consists of a flexible uterine sound with a section of rubber tubing between it and the attachment to the vibrator to prevent undue force being used, and application is made directly to the cervix through an ordinary speculum.

Chancroid may be treated with the spark from the vacuum tube or by caustic fulguration. One treatment should suffice and is superior to acid cauterization Take care not to apply too long. One-half to one minute is usually sufficient. Sometimes I place the vacuum tube over the chancroid with two or three layers of gauze between, thus utilizing short but rather thick sparks. In this instance keep in contact for five minutes and repeat in eight to twelve hours. The ozone spray will hasten a cure.

Where a soft chancre exists just within the meatus, treatment by means of the end of an urethral electrode is extremely satisfactory for ap-

parent reasons. Treat for seven minutes and repeat twice a day in the start.

Chilblains. Use a vacuum tube with a current strength capable of producing a quarter or half inch spark, but keep the electrode in contact with the skin. It may be held steadily over the chilblain or moved slowly about as desired. Treat for ten minutes or until relief is manifest and repeat daily or every other day until cured.

In connection the soaking of the foot in a strong solution of acetate of zinc (tablespoonful to the quart) is advised.

If a porcelain bowl is used the high frequency electrode may be placed in the solution after the manner of using the faradic current.

Chloasma. (See Moles, Moth-patches, etc.)

Chlorosis. (See Anemia and Chlorosis.)

Chorea. In chorea general treatment with a sharp stimulating spark to the spine, abdomen and extremities, taking about 15 minutes for the treatment and repeating daily or every other day, is advised.

Auto-condensation alone, or in connection with the foregoing, is indicated; also mechanical vibration and ozone.

Chronic Ulcers. Use at first a sharp spark from the vacuum tube to get a stimulating effect, which is not only locally germicidal, but also converts the

chronic condition into an acute one which will heal readily. Afterwards treat through two or three layers of gauze, with a tube in contact, capable of giving a quarter-inch spark.

Fulguration, with mild spark may be employed.

Cicatrices. (See Scars.)

Cold Extremities. I have included this symptom because it is so common and because the high frequency is really an ideal treatment for the condition.

Vacuum tube applications to the extremities to the production of redness give an immediate result.

In order that it may have a permanent effect, a tonic dose along the spine and over the abdomen is advised; the treatments to be repeated three times a week.

Diathermy is also indicated. (See Chapter XI.)

Colitis. (Inflammation of colon, mucous colitis.) This is a condition which has not yielded to ordinary methods, but which has proved singularly amenable to the high frequency current.

Several methods of employing it have been almost equally effectual. They are:

1. The vacuum tube with a current intensity capable of emitting a half or three-quarter inch spark may be passed lightly over the bowel area, either in contact with the skin or through the underclothing. Duration, fifteen minutes. Repeat daily until improvement takes place, and then continue three times a week until cured.

2. The Tesla current or the direct D'Arsonval (diathermy) applied with one electrode over the bowel and the other in the rectum.

3. Auto-condensation, either general or local or by the "plate-glass" method. (See Chapter VI.) Ten or fifteen minute treatments daily or every other day.

Auto-condensation may be combined with any of the other forms. It is my preference. 2,500 E. daily.

Constipation. I believe mechanical vibration and the sinusoidal current are superior to high frequency in these cases, but the latter may be used advantageously.

A vacuum tube application over the abdomen is indicated. The lower the frequency the more effective the treatment.

For this reason treatment with the small Tesla coils is especially satisfactory; also the use of pulsatory currents, (tube attached to one pole of X-ray coil).

Considerable current should be passing through the tube, averaging an intensity capable of delivering a spark of from one-half to one inch, but

taking care to keep the electrode in close contact with the abdomen and thereby avoid any sparking.

Ten minutes daily is advised first, later dropping to two or three times a week.

Another method is to use the Tesla current or the direct D'Arsonval (diathermy) with one electrode on the abdomen (stationary or moved about), and the other in the rectum. Local auto-condensation commends itself and the author's D'Arsonval surgings given with a pad or metal electrode over abdomen, will give motor effects.

Convalescence. In convalescence the general tonic effect of auto-condensation 2500 E., or a mildly stimulating vacuum tube spark to the whole body will aid the patient in regaining strength.

Corneal Opacity. Applications are made with the eye tube through the closed lids or may be made directly to the cornea, taking care to have perfect electrical contact. Three to ten minutes at a treatment, frequently repeated.

Corns. (See Callouses.)

Coryza. For cold in the head a low vacuum tube carrying enough current to produce a half inch spark is rubbed over the outside of the nose, along the supra-orbital region, and sides of the face.

Ozone is inhaled directly from contact with the tube or by means of an inhaler.

Intra-nasal application with the nasal electrode (See Figs. 20 and 21) is also advised.

Two or three treatments a day may be employed if necessary,

Cystitis. The effect of vacuum tube treatment through the rectum or urethra is remarkable in inflammation of the bladder.

In one case where many clots of blood were passing with the urine, and had been doing so for some days, it was greatly lessened after the first treatment and entirely disappeared after the second. The urethra was too sensitive to admit the sound and the treatment was administered per rectum.

The technique for urethral or rectal applications will be found in Chapter VII.

A seven minute treatment is given daily at first and then every other day. Two treatments a day may be employed if the physician thinks best. It is remarkable how fast the urine clears up in nearly all of these cases.

In acute cases I always use the rectal technique but in old chronic cases I alternate with the urethral method. In women the vaginal technique is used.

Local treatment over the bladder with the body tube is also beneficial, or diathermic currents with electrode in rectum and pad over bladder. A bipolar Tesla treatment may be given in the same manner.

Dandruff. (See Seborrhea.)

Deafness. In catarrhal deafness the high frequency current in connection with mechanical vibration will yield remarkable results in ninety per cent of the cases treated. Not that it may be expected to cure so large a per cent; but the degree of improvement will be so marked that both physician and patient will be well satisfied. The ear tube is used as outlined under ear technique in Chapter VII, the duration of the treatment being from two to seven minutes according to the toleration of the patient. The current must not be too sharp.

The sensation of heat will become so marked that the patient will tell you when to stop. If he does not, do not carry the seance beyond seven minutes, for either ear.

Two treatments a day are not too many in the start, but this is seldom practicable and we must content ourselves with from three to six per week.

Diabetes. In the earlier use of high frequency currents we were confronted by a variety of reports

regarding the effectiveness of this treatment in diabetes, but even those who gave adverse opinions concerning the disappearance of sugar, admitted that there was improvement in the patient's "sense of well-being."

I am willing to put myself squarely on record as believing **auto-condensation to be the best single remedy we have for diabetes,** and best of all it does not prevent us from using at the same time all of the other measures which experience has shown us to be valuable.

In my first cases I used auto-condensation without altering patient's diet, or prescribing any internal treatment in order to determine exactly how much reliance might be placed on this method. All specimens of urine were sent to a reputable laboratory for examination so that no personal wish might influence my judgment of results.

In one of these cases the sugar and all accompanying symptoms disappeared in the incredible time of six weeks. (There was six per cent of sugar in the beginning). Three to six months has been more nearly the average time required. The sugar has not disappeared in every case, but in no case has there not been a perceptible decrease in amount

and a general improvement where the treatment lasted over two months.

One case died in four weeks, only ten treatments being given. The acetone increased and I predicted death within two weeks. A sudden and decided increase in acetone or its appearance when none has been present, I regard as **an unfavorable sign usually indicating a fatal termination within two or three weeks.**

One of my worst cases where the patient could scarcely get to the office for treatment made such a steady improvement that in five months the sugar had dropped from seven and a half per cent to one and three-tenths per cent, he had resumed work and was gaining rapidly in weight, and I was absolutely sure a complete cure would result, when he died suddenly. The cause was apparently the result of an excess in drinking (which had been forbidden), raising the blood pressure to the point of rupturing one of the arteries in the brain.

Treatments should be given daily at first, starting with 2500 E., and if improvement is not manifest within a week increasing to twice that amount or even more. The only exception is where there is an advanced case of arteriosclerosis with marked hypertrophy of the heart muscle, when the blood-

pressure should not be diminished too rapidly.

When improvement is pronounced, decrease the dose and treat three times a week.

In examining the urine the total amount for twenty-four hours must be collected and measured and a specimen from this examined; otherwise a test for the percentage of sugar will be valueless, for if half a dozen separate specimens are examined in a day, there will be given an equal variety of percentages.

As diabetes is apparently a disease resulting from disturbed or impaired metabolism it is entirely reasonable to expect benefit from the administration of auto-condensation.

I do not enforce a rigid diet, but a regulated one.

Other operators have employed in place of the auto-condensation a vacuum tube spark over the abdominal area. Many find the X-ray of decided value, exposing over the liver.

Diarrhea. One author says, "After preliminary treatment of the canal or being assured that no foreign matter remains in it, apply tonic dosage of high frequency current over the region of the solar plexus, stomach, intestines, liver and spinal nerves." I note that he advises essentially the same method for constipation.

As few cases of diarrhea come under the treatment of the electro-therapist I am not able to give a definite opinion, but would think a prolonged but soothing treatment over the abdominal organs preferable. Inhibitive vibration I know to be effective and would advise it in conjunction.

Drug Addictions. In drug habits I have found more benefit from vibration than from high frequency currents, but the latter may be used conjointly. In **alcoholism,** a sharp stimulating spark over liver, solar plexus and fifth to ninth dorsal spinal centers is advised; also auto-condensation 2500 E. repeated three to six times per week, provided blood-pressure is high. (It is usually.)

In the **cocaine habit** use mild vacuum tube treatment to soles of feet; and to arms and legs to the point of marked reddening. If blood-pressure is low use stimulating sparks to the spine; if high give auto-condensation. In **morphine or opium users** give sharp stimulating spark over liver and solar plexus, with auto-condensation or spinal sparks according to whether the blood-pressure is high or low.

In all of these habits treat insomnia, constipation or other accompanying symptoms as advised under those headings.

Dupuytren's Contraction. For the contraction of the fascia in the palm of the hand known under this name, high frequency currents have been successfully used by Herdman.

Auto-conduction or auto-condensation, 2500 E. three to six times per week with vacuum tube sparks locally for five minutes. Mechanical vibration indicated.

Dyspepsia. The technique to be followed is essentially that outlined under atonic dilatation of the stomach. The best treatment is auto-condensation, 2500 to 5000 E. daily. It may be employed locally by the "plate-glass" method (see Chapter VI), thus making it possible to utilize the small coils for the purpose. D'Arsonval surgings (see Chapter VI) are of equal value.

Vacuum tube applications over stomach and solar plexus are advised if auto-condensation is not available. The general tonic effect of ozone inhalations or of ozonizing the air of room or office, makes it a useful adjunct.

Earache. This symptom is frequently relieved by the application of the ear tube using a mild current for from three to seven minutes, the benefit being apparently due to the heat evolved.

Another method has been the use of a flat electrode over the mastoid.

Ear Diseases. The principal diseases of the ear which are benefited by high frequency currents are: catarrhal deafness, tinnitus aurium, and chronic middle ear affections. The method of treating each of these is given under its appropriate heading.

Eczema. In the treatment of eczema the high frequency is an invaluable adjunct to the X-ray, but may be used independently of it with successful results. This disease reacts to the X-ray very quickly so that care must be used in the number and length of exposures. The high frequency is applied according to the technique described in Chapter VI, under skin diseases, where the body tube or the tube shown in Fig. 21, No. 11, is used with a sufficient amount of current to produce a spark from one-fourth to three-fourths of an inch in length, but during the greater part of the treatment it is kept in light contact with the surface, or the treatment is applied through a layer of gauze.

Where there is intense itching it is found that raising the tube to produce a moderately sharp spark proves quickly effective and is very agreeable to the patient. As with the X-ray we must be careful and not treat the case too long at one sitting.

From two or three to eight minutes daily or three times a week is advised; the shorter treatments should be given when used in connection with the X-ray. One of the high frequency X-ray tubes made to hold and apply to the surface in a manner similar to that of the ordinary vacuum tube would undoubtedly be especially satisfactory in these cases. An ozone spray (see Chapter IX) is recommended when available.

Enlarged Prostate. (See Prostatic Diseases.)

Endometritis. Treat same as cervicitis.

Enteritis. In enteritis of a chronic character high frequency currents may be expected to benefit in the same way that they benefit all catarrhal conditions. In acute forms there is a question whether the current is of sufficient value to warrant its employment when there are so many other agencies of equal or greater effectiveness that are more easily resorted to.

The treatment advised would be tonic applications over the abdomen with the vacuum tube and a mild spark; or local auto-condensation, three to six treatments per week, of ten minutes each.

Epididymitis. In acute forms a vacuum electrode applied with mild current and held in contact

with the area involved or the use of diathermy is advised. In either case a ten-minute application repeated in two or three hours until relief is obtained. In the chronic form the same method is employed. The treatments are then given daily or three times a week.

The X-ray is very effective in these cases, but on account of its tendency to produce sterility, it is sometimes objected to. The surrounding parts should be protected by a lead shield or the treatment may be applied through one of the narrow tubes or speculums connected with a tube shield.

In my experience where there has been any considerable inflammation of the epididymis, that side is already inactive, and there is no special reason to hesitate about using the X-ray.

Epilepsy. The high frequency current in connection with the X-ray has been used in treating epilepsy with a number of apparent cures according to several authors. The method employed is the use of a medium or high vacuum X-ray tube, placed at ten inches and used for five or ten minutes, followed by vacuum tube application over the brain, and along the spine for five minutes longer. Treatment is repeated three times a week.

It is questionable in my mind whether there is

sufficient benefit in these cases to warrant the use of the high frequency current.

Epithelioma. In skin cancer our best non-operative treatment is the X-ray, whether generated by high frequency apparatus or with the ordinary machine. The high frequency in the form of fulguration is also effective in the great majority of cases. Even the use of a very sharp spark, say three-fourths of an inch in length from a vacuum tube, has proved successful.

Where the X-ray is used it has been my custom to give three exposures per week, of from seven to twelve minutes, with a low or medium tube, followed by two or three minutes' application of as sharp a spark from the vacuum tube as the patient would tolerate.

We also have in carbon dioxide snow an excellent remedy for these cases. After the glands have become involved the chance of cure by any method is greatly lessened.

Erosions of the Cervix Uteri. These are treated with the vaginal tube, the insulated form being used, according to the vaginal technique described in Chapter VII, taking care to bring the tube in contact with the cervix. The treatment should last

for seven minutes and may be repeated daily or every other day, as desired. Diathermy has been used in these cases, the patient holding a metal electrode connected to the other pole. No treatment should be given during menstruation.

Exophthalmic Goitre. (See Goitre.)

Eye Diseases. The specialist will find the high frequency current a very valuable adjunct to his armamentarium. Fox, in 1907, reported one hundred cases of blepharitis marginalis treated without a single failure. My own experience in this disease dating back to 1902 will bear this out. Iritis, retinitis, atrophy of optic nerve, conjunctivitis, trachoma, glaucoma, incipient cataract, paralysis of ocular muscles, intro-ocular hemorrhage have all been treated by high frequency currents. The special technique for each of these diseases is given under the appropriate heading.

Favus. This condition which yields so nicely to the X-ray is also amenable to treatment by high frequency. A spark is employed as sharp as the patient will tolerate for from three to five minutes, three times a week.

Fissure (Anal). So many reports of successful results in anal fissure have been made that there seems to be no doubt of its efficacy. It has always been my opinion that as much benefit was derived from the stretching of the parts as from the healing effect of the current. The rectal vacuum tube is employed as directed in Chapter VII and a seven minute treatment is given from three to six times per week.

Flabby Breasts. It is claimed by Monell that a stimulating application with the vacuum tube to the relaxed nipple of the flabby breast will immediately show its beneficial effect.

Frontal Sinusitis. (See Sinusitis.)

Furunculosis. In treating boils a mild spark from the vacuum tube is employed over the affected area for ten or fifteen minutes. The treatment may be repeated two or three times a day if operator finds it advisable. It is well to cover a reasonable area surrounding the boil in order to prevent recurrences, if the boil is discharging. Another method is to use the fulguration point with a sharp spark for a few seconds. This frequently aborts a boil if employed in the early stages. Operators using the Tesla coil have told me that they obtain better results when the patient is directly attached to one pole of the machine and the grounded vacuum tube or metal point held within a short distance of the surface treated, thus drawing the sparks from the skin (indirect sparks).

Open boils heal readily under an application of the ozone spray.

Gastritis. In chronic gastritis the high frequency treatment indicated is local or general auto-condensation, or the methods may be followed which are given under atonic dilatation of the stomach.

Genito-urinary Diseases. The genito-urinary diseases in which these currents have proved useful include gonorrhea, gleet, prostatitis, cystitis, orchitis, stricture, etc. The directions for treatment will be found under these various headings.

Glaucoma. As this condition is usually associated with high blood pressure as well as hypertension in the eye-ball, the use of auto-condensation 2500 to 7500 E. daily to reduce blood pressure naturally suggests itself and it was for this reason that I first employed high frequency currents.

In conjunction with auto-condensation, I use the eye tube applied to the closed eye for five to eight minutes, when a very mild spark is employed over the eye-lid, eye-brow and temple with any flat surfaced vacuum electrode.

I do not find any record of this condition having been previously treated by anyone else. There is, of course, no reason to omit any of the customary remedies used in these cases. The benefit is noticed frequently after a single treatment.

Gleet. There are two methods that I have found equally satisfactory in the treatment of chronic posterior urethritis. The first is by employment of the urethral tube with the technique given in Chapter

VII, taking care in the introduction of the glass sound not to break it and seldom extending the treatment over seven minutes at any one seance. The treatments may be given daily or every other day.

The second method is to treat through the rectum with the rectal or prostatic tube, which I have found quite as effective, and much easier to employ and devoid of any danger from breaking of the tube. I have treated a large number of these cases, beginning as far back as 1902. The early cases were treated in conjunction with the X-ray, but on account of the risk in using the latter, I have abandoned it of late years and find high frequency currents even more effective.

Cases are cured frequently in from ten to twenty treatments; occasionally it has taken more than twice the latter number.

Goitre. In simple goitre the high frequency current is applied with the vacuum tube, using an intensity capable of producing a half or three-quarter-inch spark.

The tube should be kept in light contact with the surface of the skin, treating the sides of the neck as well as over the goitre itself. After five minutes of this treatment, raise the tube and use as sharp a spark as the patient will permit for two or three minutes.

The X-ray is used always in connection with the high frequency and mechanical vibration also. About one-half of the cases are cured.

In exophthalmic goitre the results are much better than in simple goitre.

The vacuum tube is employed in the same manner followed by auto-condensation, 2500 E. X-ray and vibration recommended.

Gonorrhea. In acute gonorrhea in the male the current is markedly benefiical. If the canal is not too sensitive the urethral vacuum tube may be used, but this is seldom possible.

A method in vogue abroad is to wrap the penis in wet cotton or gauze and wrap lead or tin-foil around it, which is connected to the resonator or to the Tesla coil, or used with direct D'Arsonval current (diathermy).

Another method is to use a glass tube containing boric acid solution and having a metal bottom to which the connecting cord is attached.

A daily treatment should be given, and I have not hesitated to give as many as three in one day in some instances.

In the female the vaginal tube is used or the vagina may be packed with moist gauze and a metallic electrode attached to the gauze.

Usual methods of treatment may be carried out in connection with the high frequency.

In sub-acute or chronic forms the vacuum tube method is preferable in either sex. In men, treatment through the rectum is effective.

The precise action of high frequency in these cases is still in doubt. It may be the germicidal effect of

the ozone liberated, or the increased leucocytosis established. With tubes of high vacuum the chemical rays emitted are entitled to credit.

Gout. Auto-condensation or auto-conduction is the high frequency treatment for gout, as in all diseases resulting from disturbed metabolism. The urine is found to have immediately an increased amount of urea, while the excessive uric acid rapidly decreases to normal.

2500 to 7500 E. daily or three times a week is a proper dosage. A slight aggravation of pain may be present after the first few treatments, for which reason I sometimes start with a smaller dose and gradually increase.

No treatments should be given during an acute attack. Arc light or electric light baths are beneficial in any stage.

Where the vacuum tube is applied in these cases, it should be kept in close contact with the skin, avoiding all sparking. Indirect spark during auto-condensation is very beneficial.

Gray Hair. I discovered, accidentally, the action which these currents have in restoring the natural color to gray hair. This apparently is not limited to premature grayness.

The chief drawback to the treatment is that it may have to be kept up for months and months.

Vibration of the scalp to aid in increasing nutrition is desirable. The high frequency treatment consists in vacuum tube applications.

From my original article on this subject, published in the American Journal of Clinical Medicine, November, 1909, I quote some paragraphs:

"As early as 1902 I began using high frequency currents, usually in connection with vibration, in the treatment of various conditions of the scalp where the hair was thin or falling out rapidly.

"Vibration was employed because of its stimulating effects on the circulation, and high frequency sparks because of this same beneficial influence on the nourishment of the hair roots, and further on account of its germ-destroying action where bacteria were responsible for the falling hair.

"The possibility that high frequency currents might be useful in restoring the original color to gray hair did not occur to me, and had it done so I should have thought it impossible in consequence of the fact that these currents have been used commercially in bleaching flour and other substances.

"My first discovery of the 'restorative' effect on gray hair came about in an accidental manner.

"I was treating a woman whose hair was falling out very rapidly, employing both high frequency current and vibration. Her hair was very black, but sprinkled over her head were three or four dozen gray hairs which were especially conspicuous by contrast. She asked me if it would do any harm to pull out the white hairs, and I told her that as long as she was losing so much hair, anyway, she might as well pull out the objectionable gray ones.

"After about two months of treatment the hair had practically ceased falling out and I noticed that there were scarcely any gray hairs. I thought she had been pulling them out and said so. When she replied that she had been afraid to do this despite my permission, I said to her that the treatment must be restoring the color and proceeded to investigate. The finding of a few hairs white at the upper end and dark for a varying distance next the scalp convinced me absolutely that my surmise was correct. From that time on I have employed high frequency currents in all of these cases that have come under my care.

"For a long time I believed that only in prematurely gray hair any improvement could be expected, but a recent case makes me think that if patient and physician are sufficiently persevering, results may be obtained in many instances where the gray hair is the natural result of advancing years.

"The case referred to is one in which I have for somewhat over a year and a half been treating a very stubborn case of lupus, situated behind the left ear. The patient, a man in the fifties, has gray hair which can scarcely be called premature.

"The treatment for several months consisted in an application of high frequency sparks six days a week, preceded every other day by exposure to the X-rays; and even now that the patient is nearly

cured he is still receiving two such treatments a week.

"Recently I noticed that around the ear where I had been applying the sparks there was a band of dark-brown hair about an inch in width. I thought possibly this was so all around the margin of the hair, but found it did not exist except over the area receiving the high frequency sparks, and a reference to a picture of the man taken when treatment was begun shows that at that time there was no apparent difference in the shade of the hair at this point.

"All of this brings me to the conclusion that gray hair must be entirely a result of disturbed nutrition, preventing the carrying into the hair of the pigment that gives it its color. This pigment-carrying property, in all probability, depends largely upon the natural electrical currents which traverse various tissues and which when interfered with in the hair result in grayness.

"Laying aside theory, results tell, and it is easy for anyone to prove the truth of my statements. The only drawback is the comparatively long time required. Some cases show results in two or three months, but six months is nearer the average.

"In the case of naturally gray hair I fear few patients could be kept under treatment long enough, since in the instance cited, a year and a half elapsed before the change was noticed.

"The method which I have employed is first to use a rubber brush or soft rubber vacuum cup on a

vibrator and for three or four minutes thoroughly massage the scalp, stroking from the edge of the scalp inward toward the center of the crown of the head, or else using short circular strokes and gradually passing from the margin to the center. Following this, a glass vacuum tube is employed and passed rapidly back and forth over the scalp for five minutes, with as sharp a spark as the patient can conveniently tolerate. This is usually one about one-half or three-fourths of an inch in length. Too sharp a spark might make the scalp sore and even have a slight caustic effect, which is to be avoided.

"Daily treatments are the best. I employ a similar technique in falling hair. Keeping the tube in loose contact with the scalp is equally effective."

Grippe. (Influenza.) In connection with the usual medicinal treatment great benefit will be derived from the general application of the high frequency current and the inhalation of ozone.

Ozone is particularly valuable in these cases, especially where the patient can have an ozonizer in the room.

Otherwise inhalations by means of any of the several generators, or in default of one, the vacuum tube held with the hand in contact with the vacuum will give a sufficient amount if brought near the nose.

The general treatment is by tonic spark to spine and solar plexus; also mild treatment over eyes and

sides of nose. (Intra-nasal with special tube is advised in certain cases.)

Hair, Falling. The vacuum tube applied as described under scalp technique in Chapter VII, especially in conjunction with vibration, is very effective where the hair is falling out. (See Alopecia.)

Hay Fever. (Periodic Hyperesthetic Rhinitis.) Many reports have been made of the favorable influence of high frequency in these cases. Direct applications to the nose with the nasal vacuum tube and mild current, also using any suitable tube to stroke over the nose externally, as in nasal catarrh, is the customary technique with tonic spinal treatment or auto-condensation as indicated.

Inhalations of ozone are of even greater importance or still better ozonizing the air of the room. The patient should be exmined for enlarged turbinates or nasal polypi and if found they should be removed.

The hyperesthetic areas in the mucous membrane should be destroyed. Fulguration sparks may be used for this purpose, although I see no advantage over customary measures.

Headaches. Frontal or congestive headaches are relieved by using the vacuum tube with an intensity capable of producing a half or three-quarter inch spark and by passing the tube back and forth over the seat of pain.

Keep the tube in loose contact and prolong the

treatment until relief takes place, which will be five, eight or occasionally ten minutes.

Inhibitive vibration in connection is advised, being fully as effective as high frequency.

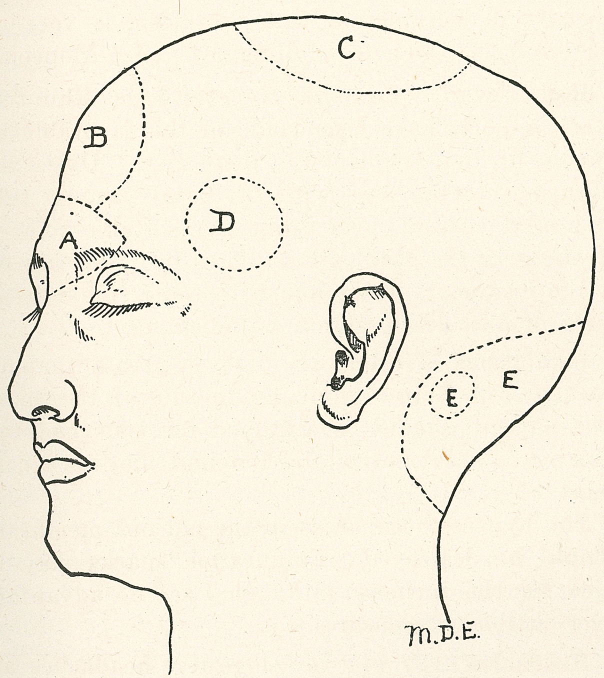


Fig. 54—Areas Where Headaches Occur.

Only temporary relief may be expected in toxie headaches or in reflex headaches from organic diseases, unless the underlying cause is ascertained and treated.

In Fig. 54, taken from my "Vibratory Technique," the areas where headaches occur are outlined. This will be useful in suggesting the probable line of treatment.

Headaches at A or B are congestive or frontal. At A they may come from errors in refraction; frontal sinus disease or nasal disease. Stomach diseases also frequently cause pain at A. Constipation A-B. Decay of front teeth A-B. Anemia; endometritis; bladder disease, C. Middle ear disease; throat disease; eye disease; decayed teeth, D-E. Womb disease; spinal irritation; nervousness, E. Ovarian reflex pains usually at C and E. Neurasthenic headaches involve the back of the neck.

Heart Disease. One author says: "Tesla currents are often of great value in organic heart disease in assisting nature to establish compensation. In later stages when compensation fails the current is palliative through its action on the vaso-motor system and its tendency to disperse dropsical effusion."

Treatments are given according to the indications shown by the patient's blood pressure. If the latter is high auto-condensation is called for; if low sparks to the spine and solar plexus.

Hemorrhoids. Outside of the use of fulguration for the removal of hemorrhoids, I am not impressed with the value of high frequency currents in these cases, despite a number of favorable reports. Of course they are palliative and relief may result from

their treatment with the rectal electrode as directed in Chapter VII, under Rectal Technique.

For well-marked cases my advice is operation. Whether they are removed by the knife or scissors, or whether by the electro-cautery, or by fulguration sparks, is a matter for individual choice.

Local anesthesia will suffice for fulguration in these cases and the spark need not be a very long nor sharp one. More than one application may be necessary.

Herpes Zoster. (Shingles.) Application of the vacuum tube discharge to the eruption in herpes is almost uniformly serviceable in hastening a cure.

The tube should be capable of delivering a quarter, half or three-quarter inch spark, but should be used in loose contact with the surface or through a layer or two of gauze. Treatment should be applied to the nerves supplying the area. Repeat the application daily as long as required. Two to four treatments ordinarily are sufficient.

Mechanical vibration advised and ozone inhalations for their tonic effect.

High Blood Pressure. (See Hypertension.)

Hyperesthetic Rhinitis. (See Hay Fever.)

Hypertension. (High Blood Pressure.) This symptom is the most common one accompanying arteriosclerosis, and the technique of treatment is given under that heading.

The technique of taking the blood pressure is described in Chapter VI.

High blood pressure always calls for auto-condensation, or auto-conduction. It also contra-indicates the application of sharp stimulating sparks to the spine, as these tend to raise it still more.

Hypotension. (Low Blood Pressure.) In this condition we have the opposite to the preceding head-

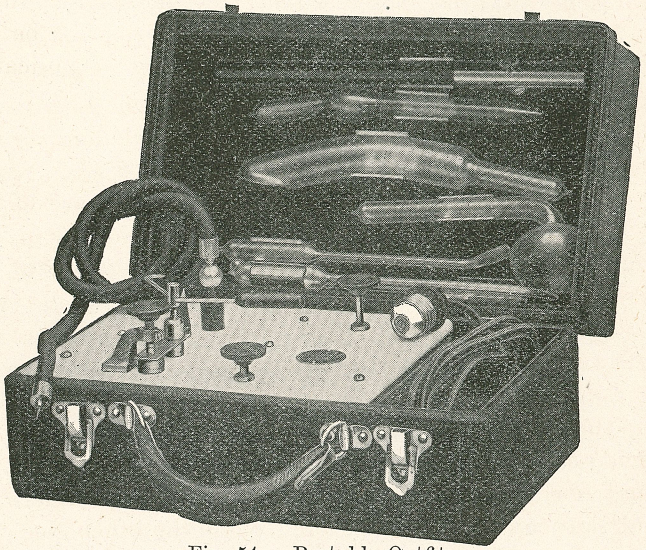


Fig. 54a—Portable Outfit.

ing, and the treatment indicated is sharp stimulating sparks to the spine and solar plexus, while auto-conduction or auto-condensation is theoretically contra-indicated, although with low pressure it does not seem necessarily to lower it, depending on the pulse pressure (See Chapter VI).

Hysteria. Many operators have reported successful results in hysteria. Anto-condensation should be used if blood pressure is normal or above.

If the pressure is below normal, as is often the case, sharp vacuum tube sparks to spine and abdomen are advised.

Impetigo. Treat according to the technique given for acne vulgaris.

Impotence. The method of treating this condition is by means of the vacuum electrode. Use the body or prostatic tube with enough current to produce a spark one-quarter or one-half inch long or more.

Keep the tube in loose contact with the surface while it is passed back and forth over genitals, inguinal and bladder region and to the lower half of the spine.

With the spinal application raise the electrode to get reasonably stimulating sparks.

Sometimes a special electrode is used which takes in the genitals, or they may be immersed in boric acid solution or water in a glass or porcelain vessel, and one pole of the D'Arsonval current (diathermic) in contact with the fluid, while the other electrode is in the patient's hand or applied to his back. Ten minute treatments daily. Rectal applications for seven minutes are often beneficial.

Incontinence of Urine. (Enuresis.) Apply a tonic spark to the lower part of the spine and also over the bladder area.

In selected cases treatment through the rectum to influence the neck of the bladder is desirable, and were it not for the fact that these cases occur in children the methods outlined under cystitis would be indicated.

Infantile Paralysis. (Anterior Poliomyelitis.) These cases call for the daily application of stimulating sparks to spine and over all of the paralyzed muscles. Use a spark one-fourth or one-half an inch in length, with body tube.

Interrupted galvanism and vibration are of equal value and should not be omitted. The tonic effect of auto-condensation makes it desirable.

D'Arsonval surgings (See Chapter VI), with the connection made directly to the ankles when the legs are affected, is of marked benefit because of the muscular contractions produced.

Influenza. (See Grippe.)

Insomnia. (Sleeplessness.) There are few cases of insomnia that cannot be cured by high frequency currents.

The technique which I have found to be most-satisfactory has been the use of a vacuum tube with sufficient current to produce a quarter or half-inch spark, which is kept in light contact with the back of the head and neck for about five minutes, followed by three or four minutes' application over the eyebrows.

After this auto-condensation, 2500 to 7500 E. I

always use vibration in connection with high frequency and ozone is indicated.

Patients often fall asleep while taking auto-condensation; in fact, when using this method for other conditons you will often find your patients asking what it is that makes them so sleepy.

I have cured so many aggravated and severe cases of insomnia with these measures that I am inclined to believe there should be no failures.

One of the worst cases I have encountered was that of a man who found it necessary, on account of the sudden death of his brother, to work night after night until two or three o'clock in the morning in order to get through with his business. This and the shock of his brother's death (he was killed by a car) caused such a state of mind and body that when it became possible for him to take plenty of time to sleep, it was found that sleep was impossible.

At the time I undertook his treatment all of the customary measures had been exhausted and powerful narcotics only gave a transient respite; in short, grave fears for the man's mind were entertained.

I refused to take the case unless the patient agreed to take daily treatments for six weeks. It was within three or four days of the end of this time before any improvement was manifest, but the second course of treatments, covering the same length of time, entirely cured him.

Intestinal Indigestion. With imperfect intestinal digestion we have indican present in the urine.

Auto-condensation, either general or local, will cure these cases. The technique outlined under atonic dilatation of the stomach is equally useful here. The sinusoidal current also has cured many cases.

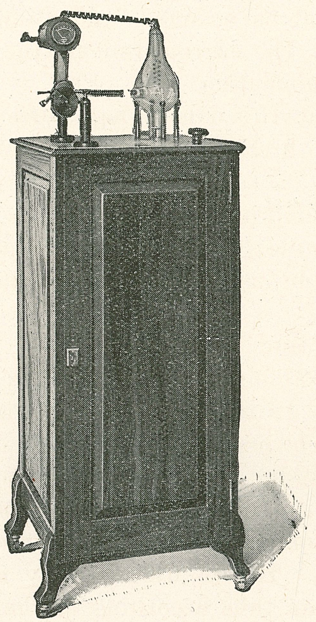


Fig. 54b—High Frequency X-ray Outfit.

The administration of suitable drugs does not conflict in the least with the electrical treatment. The diet should be regulated carefully.

Intra-ocular Hemorrhages. The high frequency

current is applied through the eye electrode in contact with the closed lid for five minutes.

The blood pressure is always high in these cases and calls for auto-condensation, 2500 to 7500 E. Daily treatments.

Iritis. Treat as outlined under eye technique, Chapter VII. The current relieves the pain and reduces the inflammation.

In syphilitic iritis I have had especially satisfactory results in breaking up the adhesions which had formed.

Keloid. Keloid may be destroyed by sharp sparks from the vacuum tube or caustic fulguration. The X-ray should be used in connection with high frequency.

Drs. Frater and Frater, Shreveport, La., have reported remarkable results in one severe case.

Laryngitis. In the acute form the application of a vacuum electrode to the throat externally, for five or ten minutes, either by loose contact or by a mild spark will greatly aid the customary medical measures. Ozone inhalations and diathermy advised.

Leucorrhea. The treatment is by means of the vaginal vacuum tube according to the method outlined in Chapter VII.

Three to six treatments a week in connection with antiseptic and astringent douches will cure these cases.

Tonic spinal sparks are advisable, frequently; also vibration.

Leukemia. Prior to 1910 I believed high frequency currents were contra-indicated in leukemia because they increased leucocytosis.

This I still consider true of vacuum tube applications (except orificial), but some experiments with auto-condensation have convinced me that in it we have a valuable aid in this disease. 2500 E. is the dose.

The following case of splenic leukemia in an early stage, as shown by the blood count at the beginning of the applications and again a short time later, is one of the arguments that won my advocacy of the treatment.

January 29, 1910, blood examination showed 3,360,000 red cells (89%); hemoglobin, 60%; white cells, 9,580 (135%); color index, .9. Besides variations in the proportion of normal white cells there were many poikilocytes and 1½% of myelocytes.

June 3, 1910, the red cells had increased to 4,200,000 (97%); hemoglobin, 90%; white cells, 7,860 (100%); color index, 1. Poikilocytes and myelocytes entirely absent.

I believe the X-ray is the best remedy we possess in alternation with arsenic, and there is no reason why auto-condensation should not be employed with both.

Lichen Planus. Use a vacuum tube in loose contact with the lesion, following the general technique outlined under Skin Diseases in Chapter VI. X-ray in connection.

Lichen rubra has yielded to the same treatment as that for lichen planus.

Lithemia. (See Gout.)

Locomotor Ataxia. (Tabes Dorsalis.) Relief of pain and improvement in gait is accomplished in many cases of locomotor ataxia. I always employ heavy spinal vibration in connection with high frequency. Apparent cures in occasional cases where even the pupillary reflex has returned has caused me to believe that we sometimes diagnose cases of multiple neuritis as tabes.

In multiple neuritis we have absence of the knee-jerk, and if the nerves of the eye were involved loss of pupillary reflex and diplopia might be present, which would apparently indicate locomotor ataxia, as the latter is the more frequently met with. This would also account for cases in which no evidences of syphilitic infection are obtainable.

In genuine cases of tabes a cure need not be looked for by this or any other method that we are at present acquainted with, but marked relief is not unusual.

I use as sharp sparks as the patient will tolerate, along the spine, over buttocks, abdomen and to the back of the legs, followed by ten or more minutes on the auto-condensation couch or pad, 2500 E.

Anesthetic areas call for short stimulating applications of the spark and also of mechanical vibration, while hyperesthetic places will call for prolonged applications of mild sparks and vibration.

Daily treatments at first; gradually decreasing to three times a week.

Low Blood Pressure. (See Hypotension.)

Lumbago. Immediate relief follows the use of either high frequency or vibration in this form of muscular rheumatism.

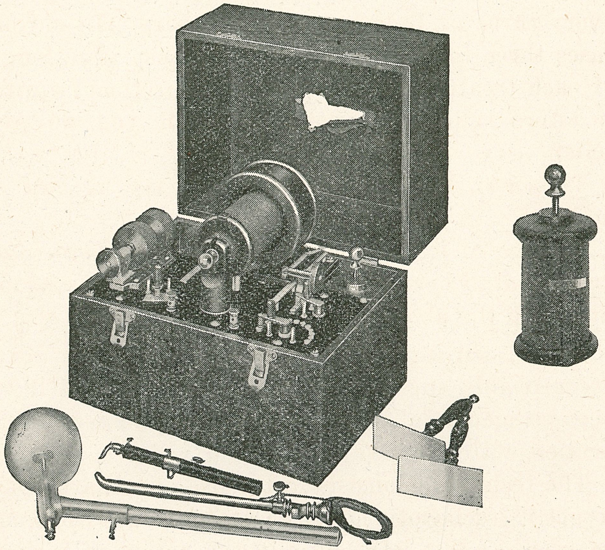


Fig. 54c—Portable Outfit with Two Inductors.

With the muscles "on the stretch" apply sharp sparks over the painful area. As the pain eases have the patient assume a different position in order to again excite pain and proceed as before until any posture may be assumed.

Customarily I precede the high frequency with prolonged (inhibitive) vibration, but the order is of no importance.

Localiezd auto-condensation is a good method to employ; also direct D'Arsonvalization, that is, diathermy.

In an acute case the treatment may be repeated every three or four hours if necessary. In chronic cases three to six treatments per week. The length of each treatment is regulated by the time required to afford relief. **Do not stop until you do give relief.**

This may be ten minutes or it may be half an hour.

The use of high candle power lamps producing a great deal of heat will be found effective in conjunction with the above method.

Lupus. In lupus the Finsen light and the X-ray are probably superior to high frequency, but it has been so successful that it should be employed in connection with the X-ray.

The technique consists in the use of a sharp spark to get its escharotic effect. Caustic fulguration may be used, as this is essentially the action of a sharp vacuum tube spark.

Nodules are successfully destroyed by this method.

Sometimes it is desirable to keep a tube of considerable intensity in light contact with the lupus instead of employing the sharp spark.

When fulguration is employed await the result of one treatment before another is given.

When a short application of the spark is made it may be used after each X-ray treatment.

The use of carbon dioxide snow is a quick and satisfactory method of treating lupus.

Mastoiditis. (Mastoid abscess.) Ordinarily I would consider it unwise to resort to any method outside of surgery for mastoid abscess.

I have succeeded in a few cases with the X-ray, and in a good many have employed the ray after operation, where the latter was not wholly successful and obtained excellent results and in these cases I made use also of the high frequency current in connection with the ray.

A special tube for the mastoid is illustrated in Fig. 22 (the upper tube).

The following quotation from Strong is pertinent: "In a severe case of mastoid abscess with cerebral and pyemic symptoms, a vigorous thirty-minute treatment with the white-vacuum electrode applied externally and a metal electrode in the mouth of the patient, produced an absolute dispersion of the acute manifestations, the patient sleeping naturally inside of five hours. The next day the pus was withdrawn, and although cover-glass preparations showed countless numbers of streptococci and staphylococci, but a few scattered colonies were obtained in a plate culture on nutrient gelatin."

Menopause. High frequency currents are particularly suited to alleviating the various nervous symptoms that accompany "change of life."

The most satisfactory method is auto-condensation, 2,500 E. three times a week.

In the absence of an auto-condensation couch make application with a mild spark along the spine; to the back of head and neck; and over the abdominal organs, taking fifteen or twenty minutes for the treatment.

Special symptoms that are present call for the treatment outlined under the appropriate heading, such as constipation, headache, etc.

Menorrhagia. (See Metrorrhagia.)

Metrorrhagia. Treatment of this condition has been successfully accomplished through the introduction of a copper electrode into the cavity of the womb, protecting the vagina by means of a rubber tube.

As these currents have shown an emmenagogue effect it is to be presumed that their opposite action in this case is due to the electrode being used within the uterus.

The cases cited were reported by Fanchon-Villeplée in the Bulletin of the French Electrical Society, February, 1905.

The direct D'Arsonval (diathermy) current seems best suited to metrorrhagia or menorrhagia.

Migraine. Temporary relief in "sick headache" may be obtained by prolonged treatment over the

seat of the pain, which usually involves one-half of the head.

Use a tube capable of producing a half or three-quarter inch spark, but keep it in light contact with the surface. When treating through the hair, in women it may be necessary to let the hair down or to reduce the strength of the current because the thickness of the hair may cause too sharp a spark.

Migraine is probably a toxic headache due to imperfect metabolism (sub-oxidation). This clearly indicates the advisability of auto-condensation.

Long treatments, fifteen to twenty minutes or even longer, if during the attack; if between attacks, fifteen minutes three times a week. Dose, 2,500 to 7,500 E. or more.

Moles, Moth Patches, Etc. Caustic fulguration is used for moles or moth patches (chloasma).

Use care and avoid destroying too much tissue. See technique for fulguration, Chapter VI.

The indirect Tesla spark with the fulguration tube is preferred by many for the removal of moles and warts.

Molluscum Contagiosum. The method of treating this skin disease is with the vacuum tube, following the general technique outlined in Chapter VI.

Muscular Rheumatism. (See Rheumatism.)

Myxedema. On account of its effect on metabolism auto-condensation has been used in the treatment of myxedema.

Daily treatments of 2,500 E.

Nasal Catarrh. For this condition the nasal tube is used within the nose with a mild current, treating for three or four minutes on each side, followed by an application to the nose externally with one of the surface electrodes.

Inhalations of ozone are of the greatest importance.

Nasal Diseases. Many diseases of the nose are benefited by the use of high frequency currents.

The technique is given under the appropriate headings, as ozena, etc.

A number of different nasal vacuum tubes are shown in Figs. 20-24.

Nephritis. (See Albuminuria.)

Nervous Debility. (See Neurasthenia.)

Neurasthenia. Numerous cases of nervous exhaustion have been reported cured by high frequency currents. When the blood pressure is high, auto-condensation, 2,500 E. daily, is usually sufficient. The average number of treatments required is from twenty-five to forty.

When the blood pressure is low, auto-condensation is contra-indicated and tonic sparks to spine, back of head and neck and over solar plexus are appropriate.

Ozone is a desirable adjunct, and in selected cases, vibration.

Neuralgia. Applications for the relief of neuralgia are made with a vacuum tube carrying current

sufficient to produce a one-half or three-quarter inch spark.

Ordinarily it should be passed back and forth over the painful area, in light contact with the skin. At

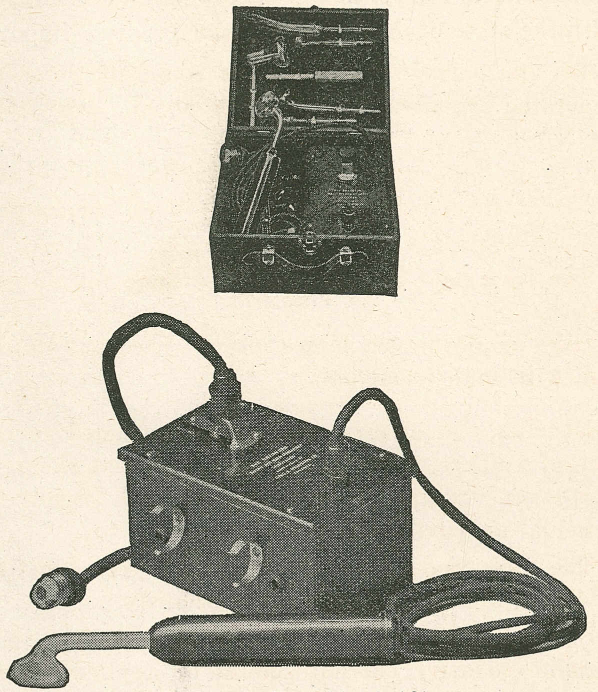


Fig. 54d—Portable Outfits.

times it is advisable to raise the tube and apply a sharply counter-irritant spark which will quickly redden the surface.

I remember the old definition of neuralgia, as "the cry of a starved nerve for blood," and certainly the high frequency will supply this want.

In addition to the local treatment, auto-condensation or spinal sparks should be applied in accordance with the state of the blood pressure.

The diathermic currents on account of the heat generated are advantageously employed. See Chapter XI.

Various names have been given to indicate the different forms of neuralgia as facial neuralgia, ovarian neuralgia, etc.

The treatment is essentially the same for all varieties.

High candle power lamps may be used in connection with high frequency.

Neuritis. In neuritis we have an inflamed condition of a nerve, the pain simulating that of rheumatism or neuralgia. Any nerve may be involved. Brachial neuritis is a common form.

The high frequency current is positively curative in all cases, but must be used judiciously.

Sharp sparks must not be employed at first, but a mild sedative current should be applied. This means that the tube should not carry more than enough current to produce a quarter-inch spark and should then be kept in comparatively close contact with the surface.

It should be explained to the patient that the first few treatments sometimes aggravate the pain.

After this stage is passed mild or medium sparks may be used, but if employed in the start the pain

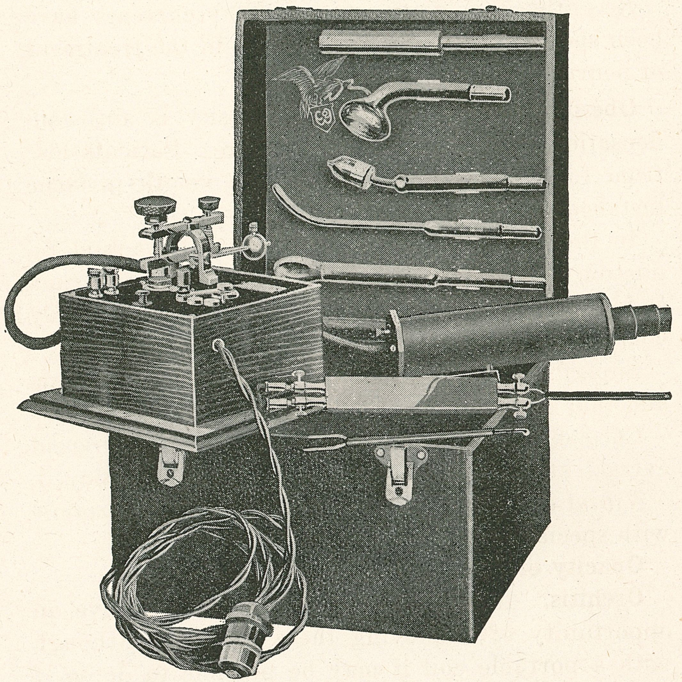


Fig. 54e—Portable Outfit with Cantery and Diagnostic Lamp.

often will be so great that the patient may abandon the treatment.

I always give auto-condensation, 2,500 E., in con-

nection with the local application, unless the blood pressure is quite low. Many cases have been reported cured by this general treatment alone.

Recently the diathermic or heat currents have been shown to be very satisfactory in the treatment of neuritis.

Obesity. The treatment for obesity is auto-condensation, 2,500 to 7,500 E., or more. Patients lose from four to fourteen pounds per month in some instances.

In those that do not show as great an actual reduction in weight there seems to be a re-distribution, so to speak, of the fat, which greatly increases bodily comfort.

Superfluous fat is a result of imperfect metabolism and that is why auto-condensation is beneficial.

Cormelles has noted a greater tolerance of thyroid extract after auto-condensation has been employed.

Vibration is indicated and the method of Bergonie with special faradization chair.

Opacity of Cornea. (See Corneal Opacity.)

Orchitis. In the acute form we seldom have an opportunity of employing these currents, although with a portable coil it may be possible to do so if there is electricity in the patient's home.

In sub-acute orchitis the vacuum tube is used with a mild effleuve or spark.

Guilleminot recommends the diathermic current, one pole over the testicle and the other over the spermatic cord. The X-ray is advised, protecting

the other testicle with lead-foil or treating through a speculum attached to a protective shield.

Otitis. In all forms the application of a mild current through a vacuum tube inserted in the ear will be found beneficial, alone or in connection with other methods.

In chronic suppurative otitis the X-ray is advised, also an ozone spray. This latter is sometimes administered through an eustachian catheter.

Ozena. Atrophic Rhinitis. Application with the nasal tube, and the inhalation of ozone, summarize the methods of treating this disease with high frequency.

Papilloma. The technique of fulguration for the destruction of papillomata is given fully in Chapter VI.

Paralysis. In general the treatment of this symptom calls for the application of the vacuum tube along the course of the paralyzed muscles, employing a current strong enough to produce a half or three-quarter inch spark. Part of the time keep the tube in contact with the skin and part of the time raise it above the surface to get the effect of the spark.

Bi-polar Tesla treatment is excellent and also D'Arsonval surgings (see Chapter VI).

The value of galvanism and faradism must not be forgotten and vibration is certainly useful.

Paralysis Agitans. Cases of paralysis agitans ben-

efited by auto-condensation or auto-conduction have been reported. 2,500 to 7,500 E. or more.

Two cases which I treated for a short time did not show any perceptible improvement.

Paralysis, Infantile. (See Infantile Paralysis.)

Paralysis of Sphincter Ani. Tousey reports marked improvement produced by fifteen treatments. Rectal applications and sparks to spine.

Pelvic Abscess. Use the vaginal vacuum tube for seven minutes, repeating daily or twice a day; also mild applications externally over pelvic region.

Diathermy advised. See Chapter XI.

Pelvic Adhesions. Intra-vaginal vacuum tube treatment and mild spark over abdominal area. Three to six treatments per week. Vibration advised in conjunction. The D'Arsonval current is preferred by some operators either by the direct method or by auto-conduction, while others prefer the bi-polar Tesla current.

Pelvic Exudates. The same technique is followed as in pelvic adhesions.

Periostitis. The vacuum tube carrying a medium intensity of current is passed lightly back and forth over the diseased area for from five to ten minutes, three times a week, followed by a few minutes' application of the X-ray, or the high candle power light.

Condenser electrodes are preferred by some operators.

Pharyngitis. In the acute form diathermy is useful in combination with customary remedies, or the vacuum electrode may be employed.

In the chronic form the spark may be used to destroy the follicles in the throat. See Fulguration, Chapter VI, for technique.

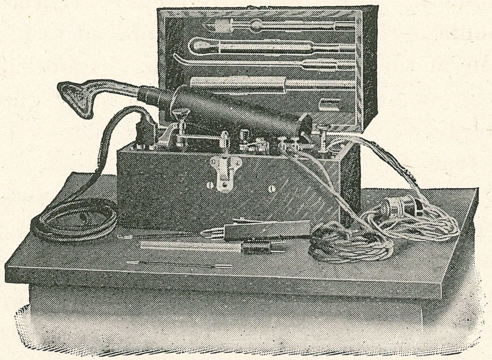


Fig. 54f—Portable High Frequency.

Phlebitis has been relieved by mild vacuum tube applications, keeping the tube in light contact with the skin. Customary methods should be kept up at the same time.

Piles. (See Hemorrhoids.)

Pityriasis. Follow the general technique given for skin diseases in Chapter VI.

Pleurisy. Treat through a layer or two of clothing, using a medium intensity of current (one-quarter or one-half inch spark) and apply over both the front and back of the chest, keeping up the treatment for a long time until marked reddening of the skin indicates a proper degree of counter-irritation. Three treatments a day if necessary in the beginning, in conjunction with usual medicinal methods. Chronic forms call for ozone and usually for the X-ray.

Pneumonia. The high frequency treatment of pneumonia is the same as that employed in pleurisy, as given in the preceding section. In addition the inhalation of ozone by ozonizing the air of the room is absolutely essential and always should be employed from the start.

It is much more sensible to administer this form of oxygen throughout the disease than it is to administer oxygen as a last hope in extremis.

Post-fracture Conditions. The local application of the vacuum tube discharge in conjunction with vibration is of great benefit in restoring a normal condition of the parts. Its physiological action clearly indicates its value here.

Post-operative Conditions. Here the current may be applied as given in the preceding section or it may be employed by means of auto-condensation or a general vacuum tube application for its tonic effect.

2,500 E. daily at first; later two or three times a week.

Proctitis. In the chronic forms of this disease the direct D'Arsonval current (diathermy) is advised, using a metal electrode in the rectum, while a metal-

lic electrode is held by the patient. Ten minutes, three to six times per week.

Vacuum electrodes with Tesla or Oudin currents may be used.

Prolapse of Rectum. Use a mild spark over the prolapsed tissue which almost always will cause an immediate contraction. If it does not, replace and follow with a seven-minute intra-rectal treatment. Three to six applications per week.

Prostatic Diseases. The results following the high frequency treatment of all forms of prostatic disease are extraordinary.

One authority found in a large series of cases over 85% were cured. In my own experience the apparent cures have been over 90% with no case in which perceptible improvement was not present.

In enlarged prostate I was of the opinion that recent cases and those with an inflammatory infiltrate were all that could be reduced, but I have had positive reduction take place in a few cases of senile hypertrophy and I believe the possibilities in these cases are worthy of investigation.

The technique is described in Chapter VII. In Fig. 55 is shown a special form of insulated vacuum tube for prostatic treatment originated by Dr. Samuel Stevens. My spatulate tube is shown in Fig. 27. I use vibration in conjunction with high frequency in nearly all of my cases, and diathermy is advised in acute cases.

Pruritus (Itching). This annoying symptom ordinarily is relieved by the high frequency effleuve or spark. Generally speaking the vacuum tube spark is employed as sharp as the patient will tolerate, but not for a long time. In other cases light contact with the tube is desirable, giving longer treatments than with the spark.

In itching skin diseases the spark is very grateful to the patient and relief is immediate though often temporary.

Pruritus ani. Treat with spark for 30 to 60 seconds and then use rectal tube for a six or seven minute treatment. Three to six applications per week.

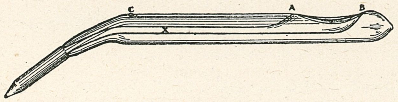


Fig. 55—Special Prostatic Electrode.

Pruritus vulvæ. The vaginal vacuum tube is used first for seven minutes, followed by a medium spark externally over the itching surface. Daily treatments if possible.

These cases frequently are caused by irritating vaginal or uterine discharges or by too acid urine. For the first use alkaline douches and for the latter give alkalies internally and see that plenty of water is drunk.

Psoriasis. This is treated by the same technique as that employed in eczema.

Purpura rheumatica. This form of purpura has been successfully treated by auto-condensation.

Pyorrhea alveolaris. (Rigg's Disease.) In this common but intractable disease of the gums the current is locally applied by means of special tubes. See Chapter XII.

The disease is very difficult to cure and high frequency is beneficial because germicidal in character as well as nutritional.

Seven-minute daily treatments with tube in contact with the gum, using adjustable socket handle so that the patient may hold the tube in place.

See complete discussion of technique in Chapter XII.

These cases always call for general treatment usually of an antacid character.

Auto-condensation is suitable on account of its constitutional effect and its marked influence on elimination.

Ozone by inhalation or by means of the local use of an ozone spray is directly indicated.

Pyosalpinx. Intra-vaginal applications of the current have proved effective in some cases of pyosalpinx. Seven-minute treatments three or more times per week.

Reynaud's Disease. I have had no experience with this disease, but French operators report successful treatment. Auto-condensation was employed 2,500 E. or more.

The number of seances varied from twelve to one

hundred and twenty-five, and in the longer cases the treatment required about two years.

Rectal Diseases. Many diseases of the rectum have been treated with apparent success, by means of these currents. The general technique is given in Chapter VII.

Among the diseases are included proctitis, fissure, hemorrhoids, prolapse of rectum, pruritus ani, paralysis of sphincter, etc. The method of treating each is given under its appropriate heading.

Renal Calculus. Dr. J. O. Chase reports the dissolving of a renal calculus by means of auto-condensation. A metal electrode was placed over the abdomen, instead of the patient holding the handles. 2,500 to 7,500 E. daily. Diathermy relieves the pain.

Retinitis. The method employed is the use of the double eye tube as in Fig. 47, or using a tube with a mild amount of current in light contact with the eye-lids, eye-brows and temple.

In 1902-4 I treated successfully a number of diseases of the eye with high frequency and X-ray, in connection with Dr. G. F. Suker, at whose suggestion these methods were employed. Among these was one case of retinitis pigmentosa.

Rheumatism. High frequency currents are of exceptional value in muscular and in chronic articular rheumatism.

In the acute articular form the results have not been so satisfactory.

Articular rheumatism, also known as inflammatory rheumatism or rheumatic fever, is known at

the present time to be an infectious disease. Ordinarily the attack is ushered in by a sore throat and the infection enters by way of the tonsils. It affects fibrous and serous tissues in particular and one reason for believing the disease infectious is the similarity between the symptoms and those of gonorrheal rheumatism where a known infection causes the pain, etc. Frequently abscessed teeth are the foci of infection.

Rheumatism is often confounded with rheumatic gout. It quickly produces impoverishment of the blood (anemia), and this is one reason why auto-condensation has proved so beneficial.

In the acute form, both articular and muscular, the application of high candle power lamps is advised in connection with high frequency, and in the chronic type, vibration is a valuable adjunct. Diathermy recommended.

In muscular rheumatism, of which lumbago, stiff neck, etc., are common types, the vacuum tube is used with either a mild or sharp spark and during the application the patient changes position frequently to keep the muscles on the stretch and to ascertain whether this posturing causes pain. The treatment is persisted in until relieved whether it be ten or thirty minutes.

In chronic rheumatism the best treatment is auto-condensation, 2,500 to 7,500 E. daily, and vaccines.

During the first treatments the symptoms may be somewhat aggravated, but after the second or third week improvement is steady and rapid.

Vacuum tube treatments over the painful area may be used in connection with auto-condensation if desired, but a cure will result without this aid.

Where the operator has no couch or pad prolonged mild treatments with the vacuum tubes may take the place of auto-condensation. In this case the application should last at least twenty minutes.

The amount of uric acid in the urine is immediately increased by auto-condensation, which probably accounts for the aggravation of symptoms in rheumatism and gout where long treatments are given in the beginning.

Dr. J. P. Sutherland, Dean of Boston University School of Medicine, furnishes the following report: "The patient commenced treatment Dec. 24, 1905, but the first analysis was not made till Dec. 31, 1905."

Date.	Total Urea.	Per cent. of Urea to Total Solids	Total Uric Acid.	Ratio of Uric Acid to Urea.
Dec. 31, '05	19.56 grammes	29.8 per cent.	1.44 grammes	1 to 13.5
Jan. 4, 06	23.66 "	36.1 "	1.11 "	1 to 21.3
Jan. 9, '06	26.96 "	46.5 "	1.001246 "	1 to 26.96
Jan. 13, '06	27.32 "	42.8 "	.7649 "	1 to 35.7
Jan. 19, '06	26.24 "	40.2 "	.667 "	1 to 39
		(Normal about) 45 per cent.	(Normal .5)	(Normal 1 to about 35 ro 40)

Williams reports one case in detail where the ratio of uric acid to urea was 1 to 51.5 before treatment. At the end of one week it had increased to 1 to 63.5; and at the end of the second to 1 to 70.3, from which point it rapidly decreased, being 1 to 64.8 at the end of the third week; fourth, 1 to 46.7; fifth, 1 to 41; sixth, 1 to 34.5. Patient's weight increased six and a quarter pounds during this time.

Both of the cases cited show the remarkable effects of auto-condensation in increasing elimination.

Rhinitis (Atrophic). (See Ozena.)

Rigg's Disease. (See Pyorrhea alveolaris.)

Ring-worm. (See Tinea.)

Rodent Ulcer. The method of treating rodent ulcer is the same as that employed for epithelioma, (q. v.).

Scars. (Cicatrices.) Vacuum tube sparks have a softening effect on scar tissue. Even contact with the tube without sparking has a similar tendency (as in treating strictures).

If the spark is made very sharp and therefore caustic or escharotic, or if caustic fulguration is used, the scar tissue will be destroyed and pliable new tissue takes its place.

For small scars about the face the application of a medium spark (one-fourth to one-half inch) is recommended, the treatment repeated in five to eight days if fulguration is employed. See Chapter VI for technique.

If a vacuum tube spark is used the treatment may be repeated daily or every other day until a sufficient degree of irritation has been set up.

Sciatica. Apply the vacuum tube along the course of the nerve and over the lower part of the spine. Use enough current to produce a spark from one-half to one-inch in length, but ordinarily do not raise the tube from the skin. Give a ten or even fifteen minute application, repeating daily or every other day.

I nearly always follow this with auto-condensation, 2,500 Eberharts.

Seborrhea. For dandruff or any seborrheic condition the vacuum tube is used, carrying enough current to give a quarter to a half-inch spark. It is then kept in light contact with the surface treated and passed back and forth about ten minutes; repeating three to six times per week.

Seminal Emissions. For nocturnal emissions sparks to the lower part of the spine are advised, followed by a seven-minute treatment of the seminal vesicles by means of the rectal tube.

Sinusitis. In frontal sinusitis I have on a number of occasions applied the vacuum tube over the sinuses, keeping it in light contact, although employing a medium intensity of current. This was always in connection with vibration.

The first time I gave this treatment it was for the

purpose of affording temporary relief until the patient could arrange to consult a specialist, as I believed operative interference necessary. I almost questioned my diagnosis when informed the following day that the pain had practically disappeared.

Subsequent experience shows that this result may be obtained in a fair proportion of cases that are seen early in the disease.

If relief is not afforded by one or two treatments, the sinus should be drained by a competent rhinologist.

Skin Diseases. The vacuum tube effleuve or spark is one of the most useful agents in treating a number of skin diseases.

The general technique is outlined in Chapter VI., while special methods are indicated under a number of the diseases, to which reference may be made.

The high frequency current should be in the office of every dermatologist. It benefits practically the same class of skin diseases that the X-ray has been employed in.

Sore Throat. (See Pharyngitis and Laryngitis.)

Sprains. Use a vacuum electrode and with a moderate intensity of current. Keep the tube in light contact while rubbed gently back and forth over the sprain. A long treatment; fifteen or twenty minutes; repeating in two or three hours if necessary.

The direct D'Arsonval current (diathermy) is equally useful. In old sprains use a sufficient spark

to produce marked reddening of the skin as counter-irritation is necessary.

Sterility. General tonic treatment by auto-condensation or by the vacuum tube is to be employed together with local treatment with the mild spark over the region of the ovaries or testicles. In women intra-vaginal treatments are indicated, and in men the use of the glass urethral tube has seemed to exert a beneficial influence, although results in these cases are uncertain.

Stiff Neck. (See Torticollis; also Rheumatism.)

Stricture of the Urethra. I have had excellent results in a large number of cases of stricture treated by means of the urethral electrode. The general technique is given in Chapter VII.

Three to six treatments a week are advised.

This method will not cure every case and galvanic electrolysis; dilation under anesthesia; or operative measures may be required.

Sub-involution. The use of an intra-uterine electrade with the direct D'Arsonval current (diathermy), as explained under metrorrhagia, is the method which gives the best results in sub-involution, although vaginal vacuum tube applications have proved efficacious.

Suppuration. Vacuum tube applications always tend to limit suppuration.

Where a suppurating area is accessible the ozone spray is the best application which can be made to it.

Sycosis. In barber's itch and other forms of syco-

sis the X-ray is our best method, but it may be advantageously supplemented by application of the spark from the vacuum tube, used in accordance with the tolerance of the patient. Mild fulguration also may be employed.

Synovitis. Treat as directed for sprains, that is, use vacuum tube without a spark, for a long sedative application in the acute form, or use the diathermic current, 600 to 1,200 milliamperes.

For the chronic case, short, thick, counter-irritant sparks are required.

Tabes Dorsalis. (See Locomotor Ataxia.)

Throat Diseases. High frequency currents are useful in connection with routine methods in laryngitis, pharyngitis, etc. See Chapter VII for general technique. A number of throat electrodes are illustrated in Figs. 20 to 23.

Tic Douloureaux. Trigeminal neuralgia has been successfully treated by applications of the high frequency current, one operator reporting the cure of a case where resection had failed. Prolonged application over the course of the nerve with medium intensity of current, but without producing a spark.

Tinea. In ringworm and in all forms of tinea the X-ray is the best treatment supplemented by vacuum tube applications, either by direct contact or by a reasonably sharp spark.

Tinnitus Aurium. The administration of the current through the ear tube as outlined in Chapter VII

has proved curative in cases of "ringing in the ears."

I always employ vibration in conjunction with the high frequency.

Tonsillitis. The throat has been treated externally with the vacuum tube in tonsillitis, following the method suggested under pharyngitis and laryngitis. It is only of value in connection with our usual methods, and is not advised as the sole treatment. Diathermy is recommended.

Tonsillotomy. I have seen a number of reports of the successful destruction of the tonsils by means of fulguration.

Judd says "For the removal of the tonsils we have in this agent an ideal method. It is bloodless, not very painful and avoids the danger of hemorrhage in fibrous growths."

Torticollis. Wry neck or stiff neck in an acute or sub-acute form is cured by vacuum tube applications along the sterno-cleido-mastoid muscle.

A long application with a tube capable of emitting a half-inch or inch spark, kept in light contact with the skin or applied through a sufficient number of layers of cloth to get short, sharp, thick sparks.

Trachoma is successfully treated by using the eye tube in connection with the X-ray, or using a tube exhausted to a vacuum high enough to give off some X-rays.

Tuberculosiss of Glands. In the treatment of tuberculous glands, the vacuum tube spark is employed

in combination with the X-ray. High frequency without X-ray is not advisable for this condition.

Any surface or condenser electrode may be used with an intensity of current capable of producing a one-half to one inch spark. The tube may be used in light contact with the skin or slightly separated to give a short but comparatively thick spark. This may be regulated by treating through a sufficient thickness of cloth. Five to ten minute applications. The best method is to give a seven minute X-ray treatment three times a week followed by the high frequency application. Ozone strongly advised.

Tuberculosis of the Peritoneum. Tuberculous peritonitis is treated by the local application of the vacuum tube over the abdominal area or by localized auto-condensation. The effleuve from a diaphragm electrode may be used.

I prefer general auto-condensation, 2,500 E. daily, with mild vacuum tube spark applied through a layer of clothing. Ozone indicated.

Tuberculosis (Pulmonary). In local forms of tuberculosis the X-ray is superior to high frequency; but in pulmonary tuberculosis conditions are reversed and in auto-condensation and ozone we have two remarkably effective remedies which should be understood better by the profession.

My attention was directed to the use of auto-condensation in this disease by Chisholm Williams' book in which he reported thirty-two out of forty-three consecutive cases as symptomatically cured, this being about 75%.

Previous to this time I employed the X-ray, using with it vacuum tube or diaphragm applications of high frequency.

I am now convinced that either auto-condensation or auto-conduction is superior to other forms of high frequency in this disease.

Ozone is especially effective in consumption and if I could only have one remedy I would prefer to take my chances with ozone. It must not be limited to inhalations at the physician's office, but the air of the patient's room must be thoroughly ozonized, so that he or she is constantly getting a suitable amount in the air they breathe. If they can only respire one-half as much air as formerly, but that amount by reason of the ozone is twice as powerful in oxidizing properties, the proper balance is maintained.

Williams observed that the use of auto-condensation was followed at first by an increase in symptoms. The expectoration increased, the cough was more frequent but easier; there was a lower morning but a higher afternoon temperature; and an average loss of weight of about a pound a week during the first three weeks. The concurrent use of ozone shortens this first stage.

After this period improvement was steady, although some attenuated tubercle bacilli were present long after all other symptoms had disappeared.

On acount of the rise in temperature produced by auto-condensation we must be careful not to give too long a treatment at the beginning if the patient is carrying a comparatively high temperature, for instance, 103 degrees or over, or is in an advanced stage of the disease.

The reaction is similar to that from tuberculin. The rise in an already high temperature might be too great if a long treatment was given. For this reason it is a good plan to give five minutes on the auto-condensation couch or pad and then await the subsidence of the reaction before giving the second treatment. I would not employ more than from 1,000 to 1,250 E. in the first three or four treatments, after which the patient will quickly establish a tolerance for the treatment and the dose may be increased to 2,500 E. or more. As soon as this period is reached daily applications are urged and should be followed by spinal sparks to offset the blood-pressure reducing effect of the auto-condensation.

In cases that carry very little temperature at the time of starting treatment, a ten-minute daily application may be made from the beginning.

The direction for the use of ozone and reports of its remarkable effects will be found in Chapter IX.

I have made it a rule to send the specimens of sputum to a reliable laboratory for examination, thus having the proof of the value of the treatment made by a distinterested party.

The following gives a comparative idea of the improvement taking place in an average case.

Mrs. B., Jan. 2, 1908. **Many tubercle bacilli present.** Other organisms not numerous. Staphylococci; dipplococci of catarrh; fibrin, mucus; pus cells.

April 8, 1908. Tubercle bacilli few, averaging about **seven to the microscopic field.** Bacilli **deep-staining**, showing **extremely few vacuolated forms.** Phagocytosis very prominent; clumping not prominent. **Other organisms noticeably absent.**

The specimen was so remarkable in the marked degree of phagocytosis and the absence of other organisms that the physicians in charge of the laboratory took occasion to call me up and ask the nature of the treatment employed.

Two months later this patient was so well that she refused to continue the treatment, having regained her normal weight and strength, although an occasional bacillus was still to be found.

The value of ozone and of auto-condensation is so marked and so easy of demonstration that I am surprised the methods are not better known, and in general use in institutions for the treatment of consumption.

They possess the advantage not only of being curative in themselves but also of not preventing the use of all the established methods of treatment in connection with them. **They afford two additional non-interfering methods of equal value with any used,**

and thereby increase the patient's chances to that extent.

Ulcers. (See Chronic Ulcers.)

Urethritis. The directions for treating specific urethritis will be found under gonorrhea. Non-specific forms yield to the same methods.

Uric Acid Conditions. All methods of employing high frequency currents aid in eliminating both urea and uric acid, but auto-condensation and auto-conduction are especially effective.

Their value can be tested readily and is easy to ascertain by a few urinalyses.

Urticaria. (Hives.) Vacuum tube applications using a medium spark or with the tube in contact with the surface is the method of treatment.

Speaking of the value of high frequency currents in skin diseases, Dr. C. W. Allen says in the Medical Record: "The vaso-motor effects may be well studied in urticaria. Here sparking the wheal produced entire disappearance of the lesion, which is replaced in a few moments by a blanched area. Vascular redness soon returns, the area of this being larger than the lost wheal. The effect of contraction followed by dilatation is very marked. The spray soothes the itching. Internal measures are not to be neglected."

Uterine Diseases. Treatment through the vagina to the womb has been beneficial in cervicitis, endometritis, etc. The general technique is given in Chapter VII. High frequency currents are always

indicated in inflammation of any mucous membrane. See Cervicitis.

Vaginitis, whether simple or specific, is treated according to the technique given under gonorrhea in the female.

Varicocele. A medium spark applied over the scrotum has been used, also immersion of the scrotum in a glass vessel with metallic connection to one pole of the D'Arsonval circuit, the other held in the hand. The current may be applied with two metal electrodes so placed as to include the varicocele between them. My own opinion is that the only real cure for varicocele is the radical operation.

Varicose Ulcers. "Long, thick, muscle-toning, high potential sparks over the affected limb; on the spinal centers, and upon the general muscle masses of the entire body for alterative, nutritional, circulatory benefits are indicated." (Monell.)

Warts and other small growths may be removed by fulguration, as described in Chapter VI.

Writer's Cramp. This is an occupation neurosis variously known as piano player's cramp, telegrapher's cramp, etc. It is the result of repeated use of the same muscles to the point of exhaustion and chronic fatigue. The vacuum tube is used with a current sufficient to produce a quarter or half-inch spark. The tube is kept in light contact with the skin and the application is made from the finger tips to and including the shoulder area, brachial plexus and upper spinal centers. For the latter the tube is

raised to obtain a stimulating spark, and I frequently employ the spark for the whole treatment. The use of vibration in conjunction is strongly urged. Three treatments a week.

Many authorities advocate general eliminative treatment in connection, such as auto-condensation or electric light baths.

Wry Neck. (See Torticollis.)

CHAPTER NINE.

Ozone; How Produced; Physiological Action; Dosage; Indications and Principal Diseases in Which It Is Employed.

Nature and Production. Whenever an electric spark passes through the air, ozone is liberated. Ozone is known under the chemical symbol O_3 and is an allotropic form of oxygen. At the same time that ozone is liberated, nitrous and nitric oxides are also produced. The less the perceptible spark accompanying the production of ozone, the less the amount of these objectionable oxides, and in administering the ozone, it is necessary by filtration or otherwise, to dispose of these gases.

Physiological Action. Ozone increases the oxygenation of the blood and tissues, increasing oxyhemoglobin and also increasing the number of red blood corpuscles. It is claimed that a decrease in white blood corpuscles is produced if they are above normal. In a strongly concentrated form, ozone is destructive in its effect on mucous membranes and even to life itself. Germs are destroyed by it and it has been shown capable of so thoroughly disinfecting sewage that the filtered water was pronounced suitable for drinking purposes. It is distinctly

deodorant and even a small ozonizer running in a room will quickly destroy the most objectionable odors.

In a Chicago bank an ozone machine was placed in a room where six employes were working. Their weight and chest expansion was taken at the time the machine was installed and again in sixty days. The result is shown in the following table:

No.	Nov. 6	Jan. 6	Nov. 6	Jan. 6	Nov. 6	Jan. 6
1	127.5	128.25	35.	36.	31.	32.
2	118.	121.5	34.25	36.	31.5	31.5
3	130.	131.25	34.25	36.5	30.	30.5
4	123.	126.75	34.25	36.75	30.5	30.5
5	131.	138.5	35.	37.5	30.5	31.
6	118.	117.50	31.75	32.5	29.	29.

Indications. In one sense of the word, since oxygen is so essential, it might easily be claimed that ozone was indicated in any bodily ailment, and I am of the opinion that its inhalation would be beneficial to the extent that pure air would be desirable, but there are some diseases in which it is of particular benefit. Among these are anemia; all diseases of the respiratory organs, including tuberculosis; infectious diseases; and all conditions where there is imperfect oxidation and impaired nutrition. An ozone spray has been demonstrated to be healing in all forms of ulcers, etc.

Methods of Administration. As ordinarily employed, ozone is administered in the form of inhala-

tions in the doctor's office, or by ozonizing the air of the room which the patient occupies. In employing the ozone directly from the generator, it has been found necessary to filter it through essential oils in order to remove the nitrous and nitric oxides. Oil of pine two parts and oil of eucalyptus one part is a favorite form. In many instances it seems to me to be much more sensible to administer constantly ozonized air than to depend upon occa-

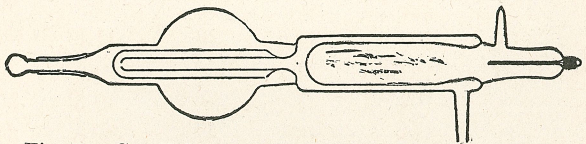


Fig. 56—Small Ozone Generator for Portable Outfits.

sional inhalations. This is especially true in consumption. Several ozone generators are illustrated herewith.

Effect on Nutrition. The following is taken from reports by Doctors L'Abbe and Oudin before the Paris Congress for the study of tuberculosis:

"We investigated the influence of ozonized air on nutrition in general, and especially in anemia or persons physically reduced. When the percentage of oxyhemoglobin is below normal (say 9% to 10%), as is usually the case with tuberculosis patients, inhalations of ozonized air for a quarter of an hour increases it by 1%. The increase, temporary at first, becomes permanent after a number of treatments,

and one can affirm that at the end of two or three weeks' treatment, the patient has reached a normal figure.

"This is necessarily accompanied, in the case of anemic patients, by more energetic oxidation, more rapid combustion, which calls for more rapid renewal of nutritive materials (increased metabolism) and from this there speedily arises an increase in appetite, which in some patients takes the form of a demand for food such as has been hitherto unknown to them, with return of strength, disappearance of complications, in short, restoration to health.

"Out of twenty-eight patients weighed before and after treatment, including those in all stages of tuberculosis,

One gained 1.1 lbs.	Six gained 3.3 lbs.
Three gained 4.4 lbs.	Two gained 2.5 lbs.
One gained 6. lbs.	One gained 6.6 lbs.
Two gained 7.7 lbs.	Three gained 8.8 lbs.
One gained 9.9 lbs.	One gained 11. lbs.
Two gained 15.2 lbs.	One gained 19.9 lbs.
One gained 23.1 lbs.	Two remained stationary.

"With the return of flesh there was a corresponding increase in oxyhemoglobin as follows:

Two gained 1%.	Ten gained 3%.
Five gained 1½%.	One gained 3½%.
Four gained 2%.	Six gained 4%.
Five gained 2½%.	One gained 5%.

Four were not examined."

In view of the reputation and standing of the physicians making this report, more than ordinary consideration should be accorded the statements.

Dosage. It is claimed that large amounts of ozone are capable of producing death, and that rabbits

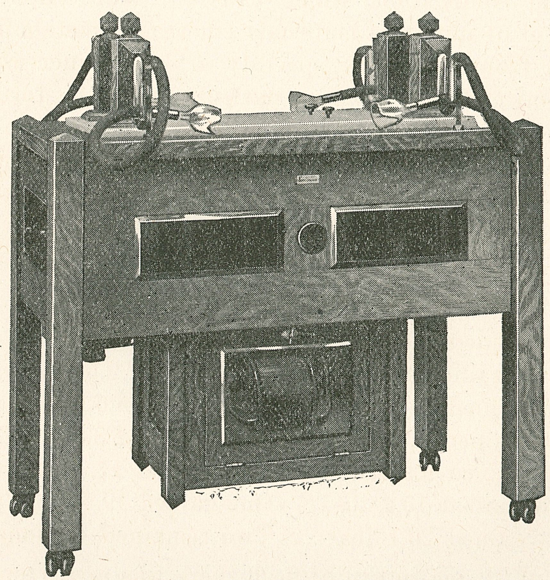


Fig. 57—Ozone Generator for Office Use.

have succumbed in ten minutes in an atmosphere containing eight milligrams of ozone to the litre. The proper proportion for therapeutic inhalation is one, two or three milligrams to the litre. Inhalations given in a physician's office last from ten to twenty

minutes and may be repeated frequently. The indication that the patient has had a sufficient dose is usually a slight sensation of lightheadedness.

Tuberculosis of the Lungs. Daily inhalations of ozone in connection with auto-condensation. Ozonizing the air of the patient's room is the best method of employing ozone in this disease. H. de LaCoux, Chemical Expert to the Council of the Prefecture of the Seine, Paris, says: "In the application of ozone for tuberculosis, it is an undeniable clinical fact that the number of bacilli in the sputum diminishes after the second or third treatment, even before the general condition of the patient is improved."

Dr. George Stoker, London, reports nine cases of tuberculosis treated within a year at the Stoker Oxygen Hospital, of which eight were discharged with the disease definitely arrested.

Dr. J. T. Gibson says in Advanced Therapeutics: "In advanced cases with cavities and much expectoration, I think there is no means of so much use as inhalation of ozone. It empties the lungs of detritus and pus, revivifying the blood, disinfecting the parts of the lungs reached, and after the first irritation of its use has passed off, there is nothing that gives the lungs the sense of rest and quiet as does this agent. I have seen the quantity of sputum lessened to a most remarakble degree, and fever disappear, and all symptoms improve by the use of ozone inhalations."

Sletoff has treated 147 cases of tuberculosis with ozone, with favorable results.

Anemia and Chlorosis. In a paper read before the American Pediatric Society, Boston, Dr. A. Caille reports the favorable influence of ozone in a number of cases of chlorosis and anemia as well as other diseases, and in his conclusion, says: "In chlorosis and anemia, ozone inhalations are exceedingly valuable from a therapeutic standpoint, and

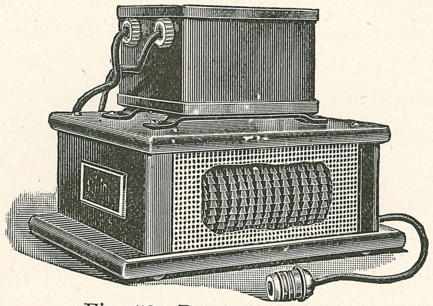


Fig. 58—Room Ozonizer.

give better and prompter results than any other form of medication."

Chronic Middle-Ear Deafness and Tinnitus. Dr. Stoker of the London Throat Hospital and of the Oxygen Hospital, has published a series of twelve cases of chronic dry catarrh of the middle ear with deafness and in nearly all with tinnitus, which were treated with an ozone spray. Improvement, sometimes remarkable, occurred in every case.

The technique consisted in passing the ozone "in

a gentle current through an eustachian catheter into the middle ear for about four minutes at a time, the operation being repeated several times a week, daily if possible.

Whooping Cough (Pertussis). The efficacy of ozone in treating whooping cough has been attested by many authorities, among them being Caille, L'Abbe, Derecq, Doumer, Delherm, Bordier and Oudin. In practically all of these cases the ozone was administered in ten to twenty minute inhalations. Ozonizing the air in the patient's room should prove a better method.

Says L'Abbe: "My personal experience rests on over 100 cases. In all I have obtained amelioration, prompt and rapid at first, and later a complete cure in a time ordinarily covered by a very light attack. Ozone is the remedy par excellence for whooping cough."

Asthma, Bronchitis and Hay Fever are benefited or cured by ozone. Inhalations combined with ozonization of the air of the room is the method; the latter being more efficacious.

Hay fever victims have found that the use of a room atomizer constantly for two or three months prior to the expected attack has prevented the latter from coming on. During the attack inhalations have given great relief.

Insomnia. Daily inhalations for ten or fifteen minutes, or havve patient sleep in a room with an ozonizer in operation.

Pneumonia. Ozonize the air in the room, keeping the machine near the head of the patient's bed.

Nervous Debility, etc. Three to six ozone inhalations per week, preferably in connection with autocondensation or with vacuum tube sparks.

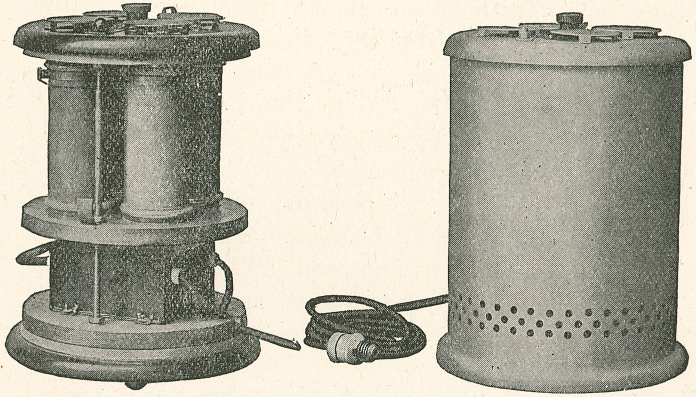


Fig. 59—Room Ozonizer.

Other Diseases. On account of its oxidizing properties, ozone should be a valuable adjunct to autocondensation in diabetes, gout, obesity, etc.

Its beneficial action in syphilis has been attested by many physicians.

CHAPTER TEN.

High Frequency X-ray; Its Nature; Generation and Therapeutic Indications.

Explanatory. This is intended as an elementary chapter on the X-ray for the possessor of a small or portable high frequency outfit who wishes at times also to avail himself of its X-ray possibilities.

Scope of Portable Outfits. Portable outfits are constructed on the Tesla type, and it is surprising how well some of them light up the X-ray tube. They are suitable for the treatment of skin diseases and all superficial lesions. This includes practically all of the conditions in which the X-ray is really effective. For radiographic purposes the manufacturers only claim them to be capable of skiagraphing the extremities, although some of them make satisfactory pictures of thicker parts. Their portability is at times of considerable advantage. They are not claimed to take the place of the larger equipment in the office of the radiologist, but bring the use of the X-ray and high frequency within the reach of many physicians who wish to employ it in connection with their regular work. They are not suited to the requirements of the X-ray specialist.

Nature of the X-ray. The X-ray was discovered by Roentgen in 1895 It possesses the property of penetrating supposedly opaque bodies, but cannot be seen by our eyes, nor felt as it passes through the body. It is produced by means of a tube exhausted to a vacuum of one-millionth of an atmosphere.

The Tube. For high frequency coils a special X-ray tube is required. These are of various shapes, some monopolar and some bipolar. One form is shown in Fig. 62. The metal disk in the center is called the target or anti-cathode and at this point the X-ray is generated. According to the degree of vacuum existing in the tube it is spoken of as high, medium, or low. The higher the tube the greater penetration its rays possess.

Adjusting the Tube. There are gauges for measuring the penetration of the tube.

To accomplish results in X-ray treatment the rays must be stopped and absorbed by the area including the lesion treated. For this reason the higher the vacuum and therefore the greater the penetration of the rays the farther away the tube must be placed from the part treated.

The average distance for a low tube is from 4 to 8 inches; medium tube, 8 to 12 inches; high tube, 12 to 20 or more inches.

Protecting Patient and Operator. As an overdose of the X-ray is injurious, it is necessary to guard

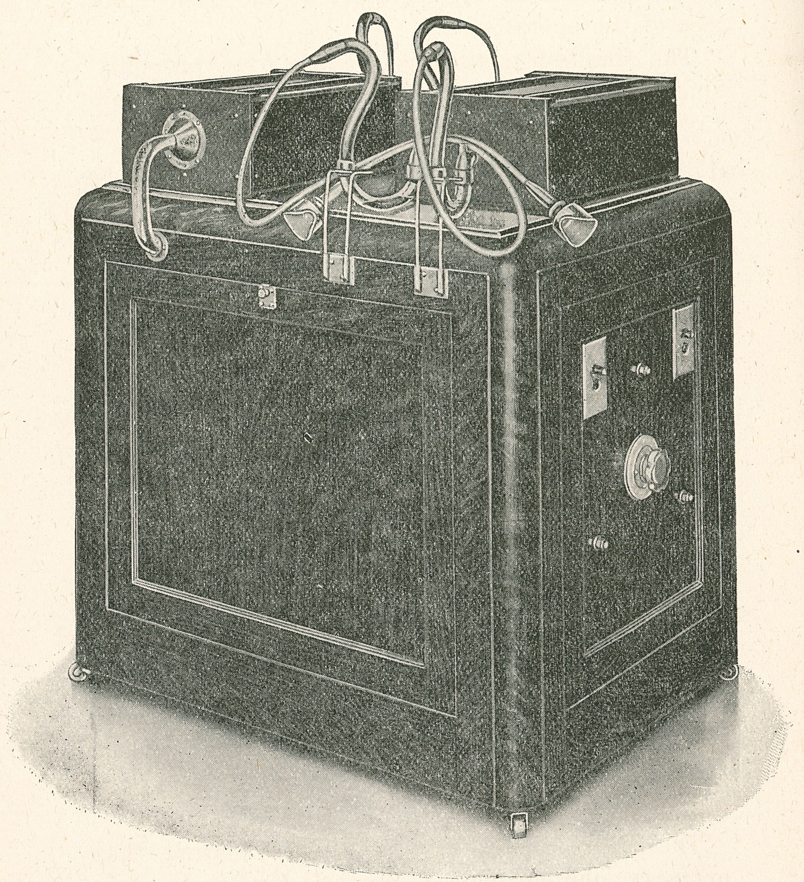


Fig. 60—Large Office Ozone Generator.

against indiscriminate exposure of the patient and also of the operator.

The simplest method is the use of a protective shield to encircle the tube, permitting the exit of the rays only through a small aperture that may be regulated as required.

In addition the use of leadfoil or sheet lead to cover all parts which are to be protected from the ray is customary.

The Fluoroscope. In order to see the findings of the X-ray a screen is employed containing barium platinum cyanide, a substance which shines or fluoresces when exposed to the X-ray. Interposing an object between this screen and the X-ray tube produces a shadow on the screen commensurate with the amount of the ray which has been prevented from reaching the screen. We have, therefore, a shadow picture showing the relative density of the object traversed by the X-ray.

The Skiagraph. The rays act upon the bromide of silver gelatin coating on photographic plates in the same manner as ordinary light. When a plate takes the relative position of the fluoroscopic screen the resultant picture is called a radiograph, or skiagraph, and affords a permanent record of the condition shown.

The X-ray plates have a heavier coating than ordinary photographic plates and are enclosed in two envelopes so that they may be handled in daylight. The flaps on the envelopes are on the non-

sensitive side of the plate. The plate is placed on the table, the part to be skiagraphed resting on the plate and the tube some distance above, the target being directly over the center of the part radiographed.

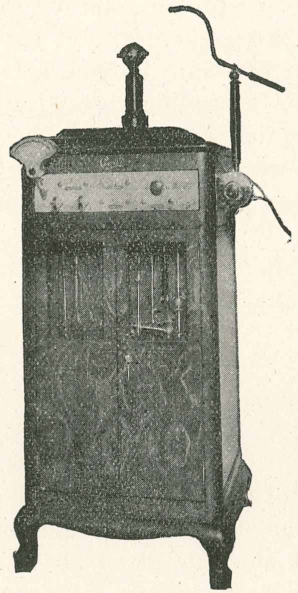


Fig. 61—High Frequency Coil Giving All Modalities.

As the rays diverge from the point on the target where they are produced, the image on the plate is always enlarged. The nearer the part is to the tube the greater the magnification.

In order to obtain a picture without distortion of

the image the following rule must be kept in mind: **An imaginary line from the point on the target where the ray is generated to the center of the plate, must be perpendicular to the plate and pass through the center of the part skiagraphed.**

Fig. 63 shows the proper relationship of the tube, plate and hand for a skiagraph of the latter.

The length of exposure is from a few seconds to several minutes, according to the apparatus employed and the density of the parts. A few experimental pictures will enable the physician to determine the approximate time for his individual outfit.

The method for developing is the same as for ordinary photographic plates, but takes much longer, averaging about ten to twenty minutes.

Dental Films. For skiagraphs of teeth, a film is used. Two small films wrapped in two opaque paper coverings is the way they are supplied to the doctor. The film is held inside the mouth, back of the teeth, the smooth side of the paper toward the tube. Head is adjusted so that the line from target to film is in accordance with the rule given above. With small machines it will be necessary to experiment to get the time of exposure. It will average 30 to 60 seconds. The films are developed, washed and dried; the one retained by the radiographer, the other by the patient.

Diseases Grouped According to Technique. In treating with the X-ray the average number of

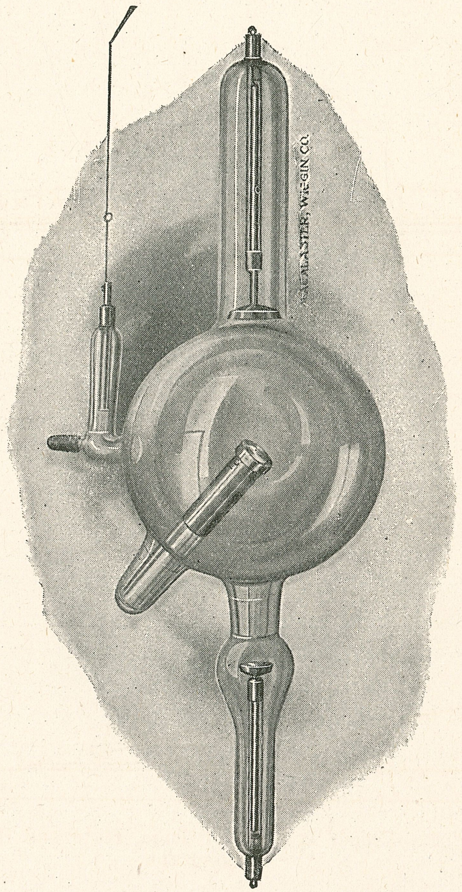


Fig. 62—High Frequency X-Ray Tube.

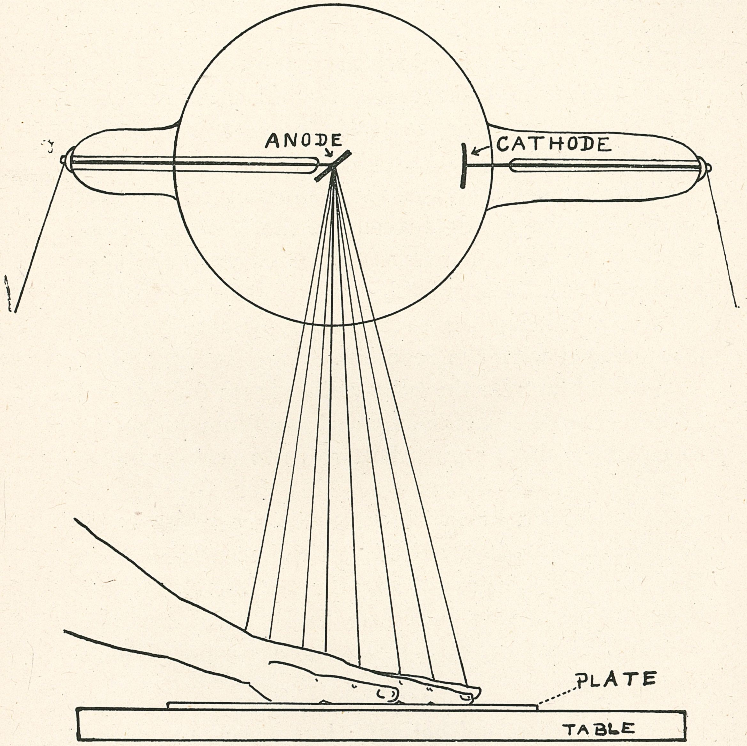


Fig. 63—Proper Position of Tube, Plate and Hand for a Skiagraph.

treatments is three per week. The length of exposure during the first two weeks should not be over five minutes each time to guard against possible idiosyncrasy to the ray.

After two weeks the treatment may be lengthened to seven, or, in some cases, ten minutes, and continued until improvement takes place or the characteristic reaction appears.

In the former instance, the frequency of the treatment is gradually decreased; in the latter it is suspended entirely for a few treatments until the signs of dermatitis have subsided, when it is resumed as before, providing the evidences of disease have not disappeared with the reaction.

With a low tube the tube-wall is from five to eight inches from the surface treated; medium tube eight to twelve inches; high tube twelve to twenty inches.

A number of diseases suitable for X-ray treatment are given herewith, grouped according to the vacuum of tube best suited to their treatment. The lower the tube the quicker the reaction produced. Some diseases are included under two headings, where it is a matter of choice, either method yielding results.

Low Tube.

Acne, eczema, epithelioma, lupus, rodent ulcer.

Medium Tube.

Acne, blastomycosis, cancer (superficial), favus, goitre, hyperidrosis, keloid, nevus, pruritus, psoriasis, sarcoma, sycosis, trachoma, tuberculous glands, neuralgia.

High Tube.

Alopecia areata, cancer (deep seated), leukemia.

X-ray Burns. An X-ray burn or dermatitis is the result of an overdose of the ray. The earlier symptoms are itching, redness and pigmentation. By

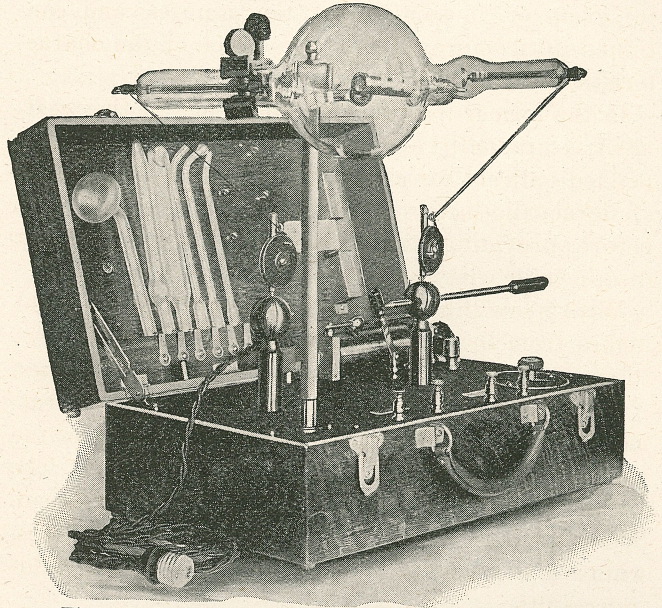


Fig. 64—Portable X-Ray and High Frequency Coil.

keeping these in mind it will be possible to avoid severe burns.

Mild burns should be let alone and they will subside of their own accord. In severe forms the condition is an X-ray gangrene or necrosis and calls for surgical measures.

CHAPTER ELEVEN.

Diathermic Currents.

Characteristics and Synonyms. As long ago as 1899, Prof. D'Arsonval noticed that passing the D'Arsonval current through certain tissues of the body produced a higher temperature in these tissues. Nagelschmidt, Doyen and others confirmed these early observations, and the name **diathermy** was applied to this method of increasing the temperature of the internal tissues of the body.

The direct D'Arsonval current is used and diathermy is synonymous also with the terms **thermo-penetration, electro-coagulation** and **electro-thermic coagulation.** The application is always bi-polar.

It really amounts to the application of **electrically generated heat,** which may be made to cover certain definite areas between the poles of the apparatus, and may be used to raise the temperature of the tissues or even carried to the point of coagulation with the formation and separation of a slough. In the latter case it is the equivalent of a surgical procedure.

We are familiar with the action of the galvanic current. If we pass this current through water, owing to electrolysis, the water is decomposed into

hydrogen and oxygen which collect at the positive and negative poles respectively, or, if the current is passed through a solution of potassium iodide and starch, a dark color is immediately noticed at the negative pole, due to the decomposition of the potassium iodide and consequent action of the iodine on the starch solution. If we dip our hand into the water while the current is passing, there is a distinct tingling sensation.

If, now, instead of using the galvanic current, we pass the direct D'Arsonval current through the water or solution, no electrolytic action is apparent and the only effect is an increase of temperature in the solution, as is evidenced by the introduction of a thermometer which shows the steady rise in temperature until the water boils. It is estimated that with the diathermic current the internal temperature of the body, located between the points of application can be raised to a temperature of 140 degrees Fahrenheit.

Effects. On account of there being practically no skin resistance to the passage of the diathermic current, the current passes directly from one electrode to the other, heating the tissues that lie between the electrodes. The current can be concentrated in this matter, and is always under absolute control. This is of great value, as a little experience will enable the operator to gauge the amount of current required to produce any given temperature in the tissues and reduces the application of

this current to exact measurement, so difficult to obtain when applying an ordinary high frequency current.

If electrodes of the same amount of surface are used on the opposite sides of a part, the same effect would be produced at each electrode or a uniform effect produced between the two, making allowance for the fact that fatty tissues heat quickly and that bones are slow to heat, but retain their heat longer, while muscular tissues are slower to heat than either fat or bones.

If we decrease the size of one electrode, since the same amount of current is passing, there will be a more intense heat over the area of the smaller electrode. If sufficient current is used the heat acts like the cautery, coagulating and destroying the tissue.

By regulating the size of the electrodes the heat may be delivered wherever desired within the tissues, thus the value of this current in all inflammatory conditions of joints, etc.

When the cauterizing effect is desired, the active electrode is usually a metal point or a wire. In this form it represents one form of fulguration. It is employed in papilloma of the bladder. (The technique is given under this heading in Chapter VI.)

Diathermic currents are measured with the hot-wire meter.

Range of Usefulness. Outside of their use in one form of fulguration as above referred to, they have been very successfully used in connection with deep

Roentgentherapy in malignant growths, and in the form of increased heat without carrying it to tissue coagulation, in arteriosclerosis, local or peripheral disturbances, sciatica, neuralgia, lumbago, asthma, neuritis, headaches and rheumatic or other forms of arthritis. Many other conditions naturally suggest themselves where these currents may be employed.

Technique. For increased internal heat, the method of the use of this current is as follows: Connecting cords are attached to electrode of suitable siez or shape for the part that is to be treated. These electrodes are made either of solid discs, or a thin brass sheet covered with absorbent material. In order to make better contact they are first covered with gauze saturated with a normal salt solution, and the part to be treated is also moistened with this solution. The control of the current is easily maintained by using a meter and the exact amount that is applied can be measured at all times. In general treatment, the current is slowly turned on until the meter shows from 700 to 800 milliamperes passing, and then it is gradually increased up to the tolerance of the patient. The operator should remember that it is better to commence with a small current and gradually and uniformly heat the part between the electrodes rather than to start with a heavier current where the greatest effect is nearer the two electrodes, for if too much current is used, the tissues near the electrodes

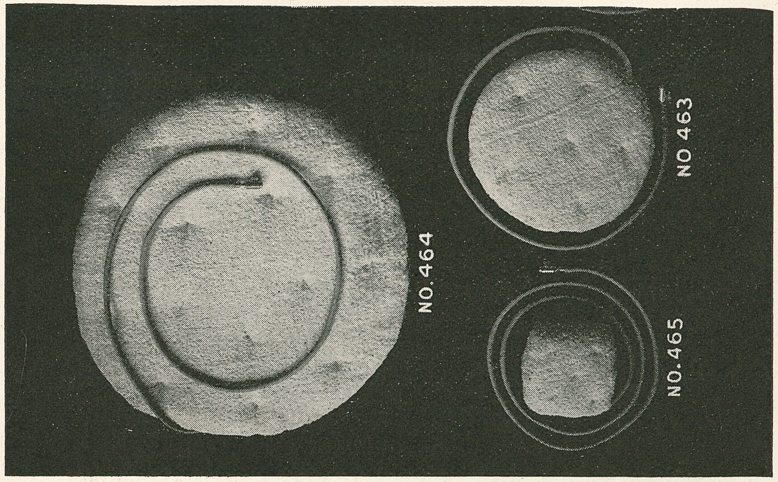
will be heated beyond the point of tolerance before the tissues that lie deeply are heated as much as they should be, and burns will be produced.

In the second method, where coagulation and cauterization are desired, the active electrode must be metallic, and if extensive work is to be done anaesthesia is required.

Dr. G. E. Pfahler (Journal Advanced Therapeutics, Dec., 1914) has accomplished remarkable results by combining this method with deep Roentgentherapy in malignant growths. The work is done under an anaesthetic, as the pain is severe. In most of his cases ether was employed, but in mouth cases hypodermic injections of one or one and a half HMC tablets (hyoscine hydrobromide gr. 1/100; morphine hydrobromide gr. ¼; and cactoid gr. 1/64) were used. These in some cases had to be supplemented by ether.

He uses an instrument capable of generating 1,000 to 2,000 milliamperes. In removing a portion of a lip he uses a ball electrode inside, about three-eighths of an inch in diameter, and a needle-point electrode externally. He says: "I would outline the area of the diseased tissue to be removed by allowing the current to flow from this point toward the ball electrode on the inside, and then coagulate the entire diseased tissue. At first I depended upon the neeedle electrode to actually carve out the diseased tissue, but now I find it simpler to cut this away with a pair of curved scissors after coagulation, always cutting within the coagulated tissue. In this way there is no bleeding and the edges are completely sealed off.

"In destroying an extensive lesion in the cheek I used a flat electrode, one inch in diameter, on the inside and a point electrode on the outside. In destroying a portion of the tongue I have used two point electrodes. The electrodes are held in contact with the tissue."



Diathermy Electrodes.

CHAPTER TWELVE.

High Frequency in Dentistry.

General Field of Usefulness. High frequency currents are coming daily into more and more frequent use by dentists. They are employed in pyorrhea, in drying cavities, in devitalizing teeth, in sterilizing rott-canals, in bleaching teeth, in abscesses, in locating devitalized teeth, and for the relief of pain. The author is not a dentist, but has tried to give in this chapter a resume of current dental opinion and technique as gathered from various sources. Several dental electrodes are illustrated in Fig. 68.

Pyorrhea. Pyorrhea early manifests itself by a slight reddening of the gums at the margins and a tendency to bleed on slight provocation. A large majority of patients having pyorrhea are anemic, and in these the gums, instead of being red, may have a yellow and discolored appearance and are apt to be flabby or receding instead of puffy. In the second stage of the disease, pus appears, attacking first the peri-dental membrane. Later the bony socket of the tooth may be slowly eaten away or destroyed. The gums gradually recede and the tooth becomes loose in its socket and painful to the touch.

From this we can see at once indications for the employment of high frequency currents.

A French authority says that it is necessary "to destroy the microbic and suppurative state of the

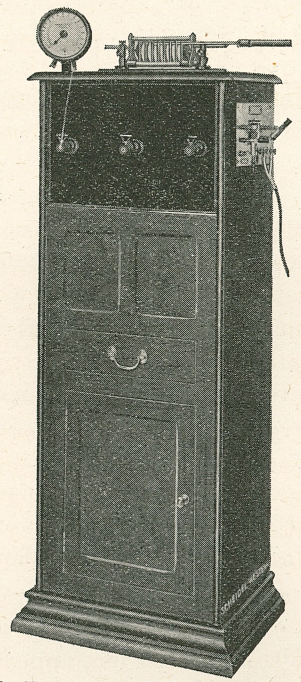


Fig. 65—High Frequency Coil, Giving All Forms, and Especially Made for Diathermy.

gums, correct the depleted nutrition in the tissues and produce an over-active phagoctosis and increase the index of leucocytic destruction. For this result

one uses high frequency currents with the greatest success in the two forms, the effleuve (spray) and the spark."

Gremeaux and Arnal (l'Est Dentaire, Sept., 1913) use the high frequency as follows: "One introduces the metallic fulguration electrode as far as possible between the loosened gum and the tooth, in order that the spark may reach all the recesses and purulent foci. During the operation, which lasts an average of a minute for each tooth, one sees the margin of the gum blanch and the pus bubble out at the neck of the tooth. When all of the recesses have been penetrated, the fulguration point is replaced by a small vacuum electrode, which is passed over the external and internal surface of the gums for about ten minutes."

They wait three or four weeks to note results before giving a second treatment, employing a rigorous antiseptic regime in the meantime, consisting in brushing with an alkaline powder night and morning, and numerous rinsings with boiled water, etc. About a week after the treatment the patient massages the gums with the finger twice a day. In three or four weeks, if pressure on the gum shows presence of pus, the treatment is repeated; otherwise the case is dismissed, with instructions to keep up the massage of the gums and antiseptic care of the month. One to three treatments were required in the cases treated.

Dr. F. Morel (Bulletin du Syndicat des Chirur-

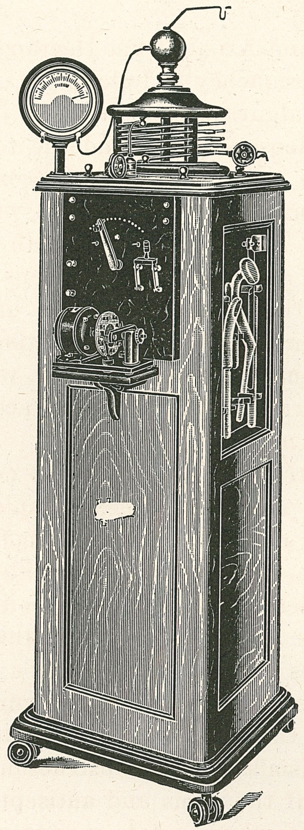


Fig. 66—D'Arsonval Outfit.

giens-Dentistes de France, Sept.-Oct., 1910, Jan.-Feb., 1911) makes use of medicaments in connection with the high frequency. He claims that the high frequency effleuve renders mucous membranes porous and facilitates the penetration of medicaments, and that the simultaneous application of the solution and the current produces an electro-chemic effect. He decomposes by the currents a solution of potassium bi-chromate, claiming that the base will be taken up by the diseased tissues.

After thoroughly removing the tartar from the teeth, he carefully irrigates with peroxide and evacuates all of the pus. Then he paints the teeeth and gums with the following solution, using a spatula to get it up as far as possible around the roots:

℞—Fluoride of Ammonia..........	1 gramme
Chloride of Ammonia..........	1 gramme
Chloride of Potash............	1.5 gramme
Salicylate of Theobromine.....	1 gramme
Methyl Alcohol	50 centigrammes
Distilled Water	20 grammes
M.—Filter.	

This solution favors ionization and lessens the resistance of the tissues to porosity.

A pad is then soaked in a ten per cent aqueous solution of bichromate of potash and held over four teeth and a vacuum electrode held over this for about fifteen minutes, with close contact. He only

treats four teeth at a time. In advanced cases he uses a metal point and carries a few sparks up into the infected canals.

The vacuum tube application is for cataphoric purposes, and one of the electrodes illustrated herewith having a cup to hold the saturated cotton may be used for this purpose.

He repeats this treatment every second day, sometimes giving three five-minute seances with eight minutes' rest between. Usually four treatments produce a cure, occasionally six, sevven or eight have been required. During the whole course of treatment the patient washes the mouth six times a day with the following solution, using half a glass each time:

Sodium salicylate	10 grammes
Sodium fluorosilicate	2 grammes
Distilled water	1 litre

Dr. Irwin Jirka applies methyl salicylate in these cases, driving it in with the vacuum electrode. He treats for eight minutes every other day. Reports a number of cases cured in three to fifteen treatments. Hubbel uses the cataphoresis electrode first and then the ball pointed pyorrhea electrode to massage the gums for five or six minutes each, treating daily until improvement takes place.

Dessication, Metallic Ionization and Phoresis. I have been furnished with a translation of a paper by Dr. A. A. Nouel of Venezuela. This paper, read

at the Dental Section of the Medical Congress at Caracas in 1911, is entitled, "Dessication, Metallic Ionization, and Phoresis of the Canals in One Sitting with High Frequency Currents." The author's methods seem to be distinctly original. He speaks of using at first a coil and resonator and with this used iodide of potash because this chemical absorbed the ozone when the current was introduced into infected root canals. After four years of experimenting he found a method and a machine that enabled him to get simultaneously metallic ionization and thermopenetration.

He says: "I have used the * * * high frequency coil, but even though the machine is just as efficient as other more powerful coils for fulguration; with vacuum electrodes and with the ozone inhaler, in the dessication of the canals, the current is found to be of too pronounced faradic character.

"I have also used several other types of high frequency machines, and found the one most suitable giving a smooth, high frequency current without any faradic sensation, such as is used in diathermy. In this case there will be felt by the patient nothing but a progressive increase of warmth, if there is no continuity of solution. If there is one, no matter how small, beside the progressive thermic increase, there will result an ionization of the canal in which a small arc will be established. This arc is formed between the walls of the canal and extends the full length of the electrode.

"The electrode is connected by means of a flexible and well-insulated metallic conductor to the right-hand 'auto-condensation' terminal. The electrode handle may be about ten centimeters long, and made of either fine wood or ivory, with a metallic point similar to that of the broach holders employed in dentistry. Small pieces of either copper or zinc

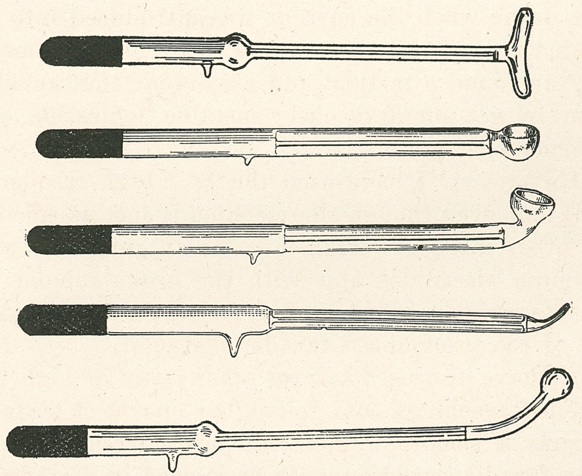


Fig. 68—Dental Electrodes.

wire, as required in each case, will be fitted to the handle. In some cases, where no abscess is formed, I believe the copper is superior to the zinc electrode. To substantiate this statement, I have observed that after a diseased spot has been treated with a copper electrode no pain is felt if that spot is touched.

"Before the current is turned on, it is better to

thoroughly dry the cavity leading to the canal in order that the sparks may not be diverted, but will confine themselves to the length of the wire and walls of the canal throughout its length.

"I firmly believe that the metal, during its ionization, is cataphorically introduced into the dental canals through the apex, and that once in the presence of the salts that form the composition of the blood, a chloride is formed, this being the reason why the peridontium and adjacent parts are irritated when zinc is employed. A zinc electrode is beneficial in case of an abscess on account of the chemical composition formed by the zinc.

"The ionized and ozonized copper is also introduced into the dental canals by means of the cataphoric action of the current, thus forming a deposit of oxide or bi-oxide of copper, which will permanently act as a disinfectant. I shall later on explain the method through which its action is brought about.

"Although a tooth may be profoundly infected (it is understood that I refer to a tooth without pulp), with inflammation of the peridontium, with an abscess or fistula, it can be 'stopped' in one sitting, fearing no ulterior difficulties, if this novel method is employed.

"The technique is very simple: After the pulp chamber is open it is to be moistened with a small quantity of trikresol and iodoform or trikresol and formalin, after which the electrode is applied, being

held at a distance of a half to one millimeter and moving it over the surface until the cavity is dry. A broach is now employed, being operated into one-half the length of the canal, drying with cotton and compressed air, not too warm; then the copper wire is introduced and the current turned on for five minutes. The broach is now used again, this time reaching to the apex. The canal now being perfectly freed from the bits of pulp and other foreign bodies, is now thoroughly dried with cotton inserts. The copper electrode treatment is then repeated for five minutes, and, after this time has elapsed the tooth may be 'stopped.'

"The great efficacy of this modality is supported by the fact that the dental canals constantly maintain a certain humidity, which serves as an easy conductor for the introduction of the ionized metal, and permits the easy access of the flowing-in process of the ozone while being dried by the thermopenetration, which goes to complete the oxidation and the consequent coating of copper, leaving it permanently deposited in a state of oxide or bi-oxide of copper."

Abscesses. The dental technique advised by some operators consists in ten or fifteen minute applications of a mild current in contact with the cheek, followed by the use of one of the cataphoresis electrodes containing cotton saturated with iodine and aconite solution. Duration of this application about eight or ten minutes. Jirka uses methyl salicylate,

and also speaks of formo-cresol, which I infer is used with the cataphoresis electrode.

Drs. Barber and Van Valkenburg have reported a case where the copper wire was employed in treating an abscess.

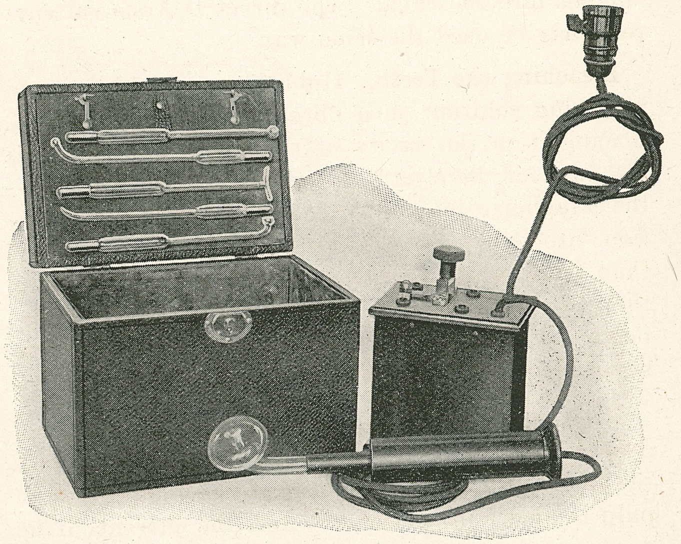


Fig. 69—Portable Outfit for Dentists.

Post-operative Pains. For the pains and soreness existing after extration or after setting bridges or crowns, the use of the cataphoric electrode with any suitable solution has been recommended, followed by application of mild current with the ball-pointed pyorrhea electrode.

Sterilizing Root Canals. Another method of sterilizing root canals is the touching of the pointed dental electrode (carrying current enough for a half-inch spark), to a broach which has previously been inserted in the canal. The broach carries the current into the canal. The direct D'Arsonval current may be used the same way.

Bleaching the Teeth. Hubbel says: "Place your bleaching solution on a fibre of asbestos or cotton, placing it in the cavity of the tooth and applying the point of the electrode directly against this fibre, the cataphoric action of the current driving the solution into the dentine, getting results much quicker than from ordinary measures. Care must be taken that the apex of the tooth is first stopped with gutta-percha so that there is no danger of the solution being forced through the apical foramen."

Diagnosing Live from Dead Pulp. The pointed dental electrode is used with a mild current, and the point applied to the cusp of the tooth. If the pulp is alive the patient will feel the current; if he does not, the tooth is devitalized.

Obtunding Sensitive Dentine and Devitalizing Teeth. "In obtunding sensitive dentine, a small crystal of carbolic acid is placed in the cavity and the pointed electrode is used in the generator, the current being toned down as mildly as possible. The point of this electrode is then placed against the cavity and held for from 30 to 50 seconds. Now,

test the cavity, and if still sensitive, use the current for a half minute longer. You may now start to excavate, and if the one application of the carbolic acid does not last sufficiently long to complete the operation, place another tiny crystal in the cavity and apply as before. In the majority of cases, operations have been rendered entirely painless by this method of treatment.

"In devitalizing the teeth a small crystal of novocain is placed in the cavity, or, if no cavity is apparent, cut into the enamel with a very small stone, placing a crystal of novocain therein and dipping the tip of the electrode in adrenalin. Apply the high frequency current to this with a very mild flow of current the same as in obtaining sensitive dentine, using the current for about one minute. Drill into the teeth until as close to the pulp cavity as possible without unnecessary pain, and again apply a crystal of novocain and use the current for about a minute to a minute and a half, and in most cases it is then possible to cut into the pulp cavity. If the nerve is then sensitive, pressure anesthesia is advisable. The greatest trouble that we find in getting success from this treatment is the inability of the operator to successfully control his current, as it takes considerable practice in order to get the proper amount of stimulation. But, after some experimenting, it is possible to get results in the majority of cases."—Hubbel.

GLOSSARY.

Names of Diseases and Terms Defined in the Text Are Omitted.

Ampere. The unit of current strength or intensity.

Anemia. A deficiency in quantity or quality of the blood.

Arteriole. A small artery.

Asepsis. Freedom from septic matter or infection.

Atonic. Lacking tone.

Atrophy. Wasting of a part.

Bi-polar. Attached to both poles of the apparatus.

Capillaries. Hair-like vessels connecting the arterioles with the smallest veins.

Carbon dioxide. CO_2. A poisonous gas eliminated through the lungs.

Carbon dioxide snow. Under high pressure the gas liquefies and on liberation the evaporation produces snow-like crystals which are moulded and applied to a growth that is to be removed. It is frozen and separates in 10 to 12 days without leaving a scar.

Cataphoresis. Driving a substance into the tissues by means of an electric current.

Coagulum. A clot.

Condenser electrode. A vacuum tube containing a metal disk which acts as one plate of a condenser, the tube wall being the di-electric and the body surface in contact, the other plate. Shown in Fig. 21.

Conductor. A material readily transmitting electricity.

Contra-indicated. Not indicated.

Dermatitis. An inflammation of the skin; used to signify the inflammation produced by an overdose of the X-ray, or X-ray "burn."

Di-electric. A substance separating two charges of electricity in a condenser, as the glass in a Leyden jar.

Diplopia. Double vision.

Effleuve. The fine spray from a vacuum tube or other electrode, too fine to be termed a spark.

Electrolysis. Breaking up a compound into its elements by means of an electric current. Electric analysis.

Elimination. Carrying a substance out of the system.

Endarteritis. Inflammation of the lining of an artery.

Escharotic. Caustic.

Exudate. A substance deposited in or on a tissue, either by vital action or by disease.

Functional. Pertaining to the natural action of a part, which may vary somewhat without an actual change in the structure of the organ or part.

Hemoglobin. The coloring matter of the red blood corpuscles, containing iron.

Hyperemia. An increased amount of blood.

Hyperesthetic. Over-sensitive

Hyperplasia. Abnormal increase in tissue elements.

Hypertrophy. Overgrowth.

Hypertension. Above normal pressure.

Hypotension. Less than normal pressure.

Ion. A moving particle of electricity.

Indican. A substance found in the urine as a result of imperfect intestinal digestion (from proteid putrefaction).

Inductance. The phenomenon of induction.

Induction. The generation of an electric current in a body by the influence of another electrified body.

Inhibitive. Producing inhibition.

Inhibition. Soothing or arresting a process or function.

Intra. Within.

Intra-ocular. Within the eye.

Intra-vvaginal. Within the vagina.

Lesion. A disease or diseased area.

Leucocytosis. An increase in the number of white blood cells.

Metabolism. The process of changing inorganic materials into living cells.

Milliampere. One one-thousandth of an ampere. The unit of dosage of medical electricity

Modality. Any one of the different forms of electricity.

Monopolar. Connected to one pole.

Myelocyte. A pathological white blood cell found in leukemia.

Neurosis. A nervous disease, especially a functional one.

Ohm. The unit of resistance to the passage of an electrical current.

Orificial. Pertaining to one of the openings or orifices of the body.

Oxidation. Combining or causing to combine with oxygen.

Oxyhemoglobin. Hemoglobin charged with oxygen in the arterial blood.

Phagocytosis. The destruction of harmful cells by cells called phagocytes which envelop and absorb them.

Physiological. Natural or normal

Plastic. Tending to build up or form tissues, as a plastic exudate.

Poikilocytes. Malformed, over-sized, non-nucleated red blood corpuscles present in pernicious and other anemias.

Potential. Electric pressure (measured in volts).

Reciprocal. The reciprocal of a fraction is the inversion of it. Thus the reciprocal of ½ is 2-1 or 2.

Serosanguinous. Serum and blood mixed.

Solenoid. A coil of wire.

Suppuration. Formation of pus.

Suppurative. Tending to form pus.

Supra. Above.

Supra-orbital. Above the orbit or eye.

Tension. 1. Electromotive force; potential. 2. Pressure, as the pressure of blood in the arteries.

Thermostat. An apparatus registering heat expansion or regulating a mechanism through this action.

Transformer. A coil that changes the voltage. If it increases it, it is called a "step-up" transformer.

Unipolar. Connected to one pole; same as monopolar.

Volt. The unit of electrical pressure.

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